# Exothermic Landscape

# FRESH KILLS EXOTHERMIC LANDSCAPE

VISUALLY AND EXPERIENTIALLY REGISTERS THE THERMAL SUBTERRANEAN, GROUND LEVEL AND AERIAL TOPOGRAPHIES OF THE CONSTRUCTED LANDSCAPE OF FRESHKILLS PARK. THE PROPOSAL, A TOOLKIT OF SITE SPECIFIC STRATEGIES AND INTERVENTIONS, GENERATES ELECTRICITY, MAKES EXISTING ON SITE METHANE PRODUCTION VISIBLE, AND ACTIVATES A SERIES OF THERMAL EVENTS-- UNEXPECTED MOMENTS OF THERMAL INCONGRUENCE.

**STRATA 1 SUBTERRAIN: EXOTHERMIC REACTION**

WASTE: AN ALTERED TOPOGRAPHY

WASTE: ANEAROBIC (HEAT) REACTION

**STRATA 2 GROUND: RADIANT SURFACE**

SOIL: THERMAL MASS

METHANE: INFRASTRUCTURAL MATRIX

METHANE CAPTURE: SURFACE BREACH

VEGETATION: EVAPOTRANSPIRATION

**STRATA 3 SKY: BUOYANT REGISTRATION**

THERMAL BOUNDARY: SURFACE / SKY INTERFACE

TURBULENCE: WIND EDDIES AND POCKETS

IRRADIANCE: SOLAR ABUNDANCE

**THERMAL EVENTS** DRAW FROM DISTINCT MICROCLIMATE CONDITIONS OF THE CONSTRUCTED TOPOGRAPHY AND HEAT EMITTING SURFACE OF THE LANDFILL. UNEXPECTED EXPERIENTIAL INTERFACES EMERGE. HOT MEETS COLD. BLUR MEETS CLEAR. STATIC MEETS SWAY. TURBULENCE MEETS CALM. EVENTS CORRELATE TO KEY SITE STRATA.

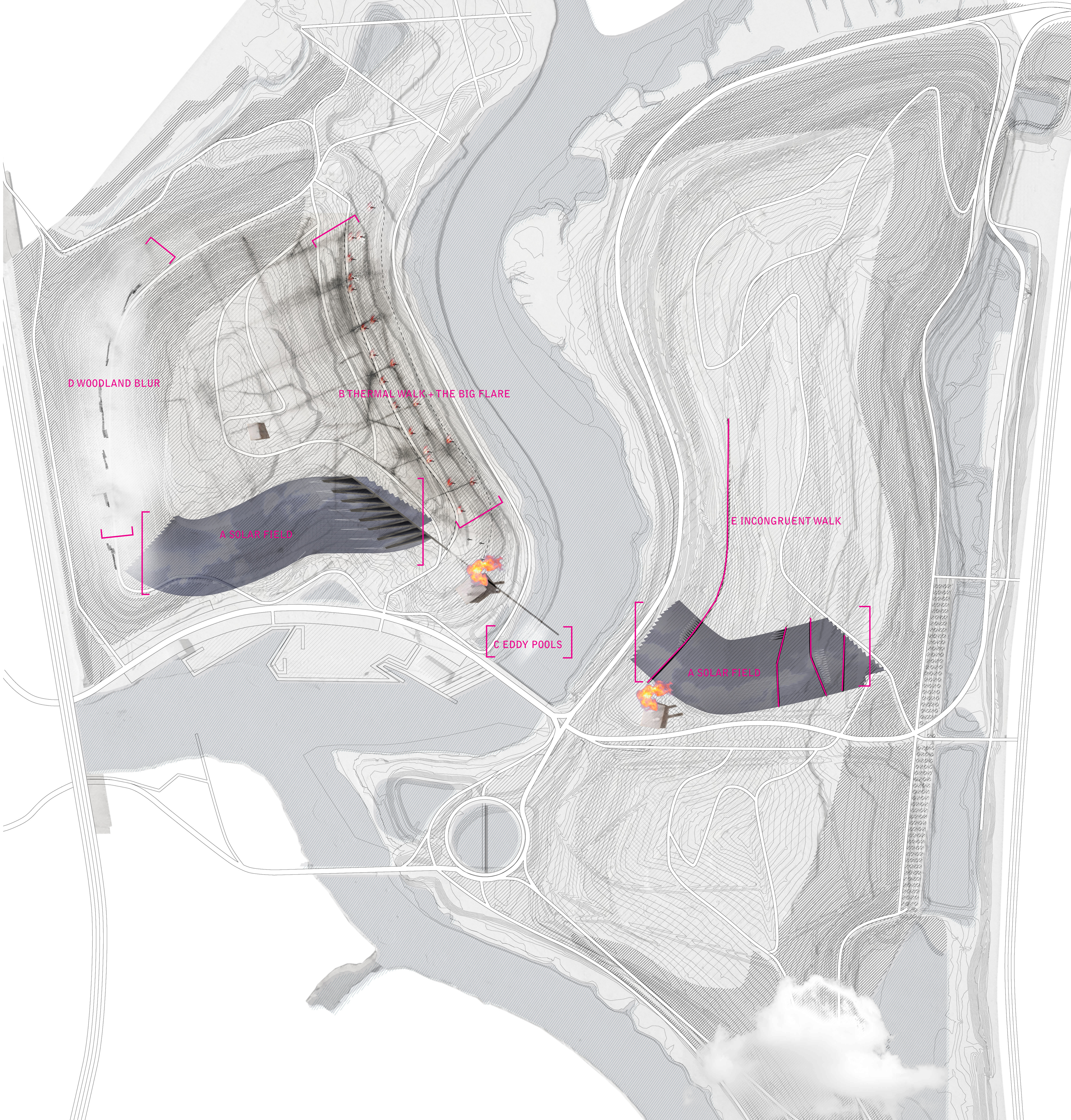
A SOLAR FIELD

B THERMAL WALK + THE BIG FLARE

C EDDY POOLS

D WOODLAND BLUR

E INCONGRUENT WALK



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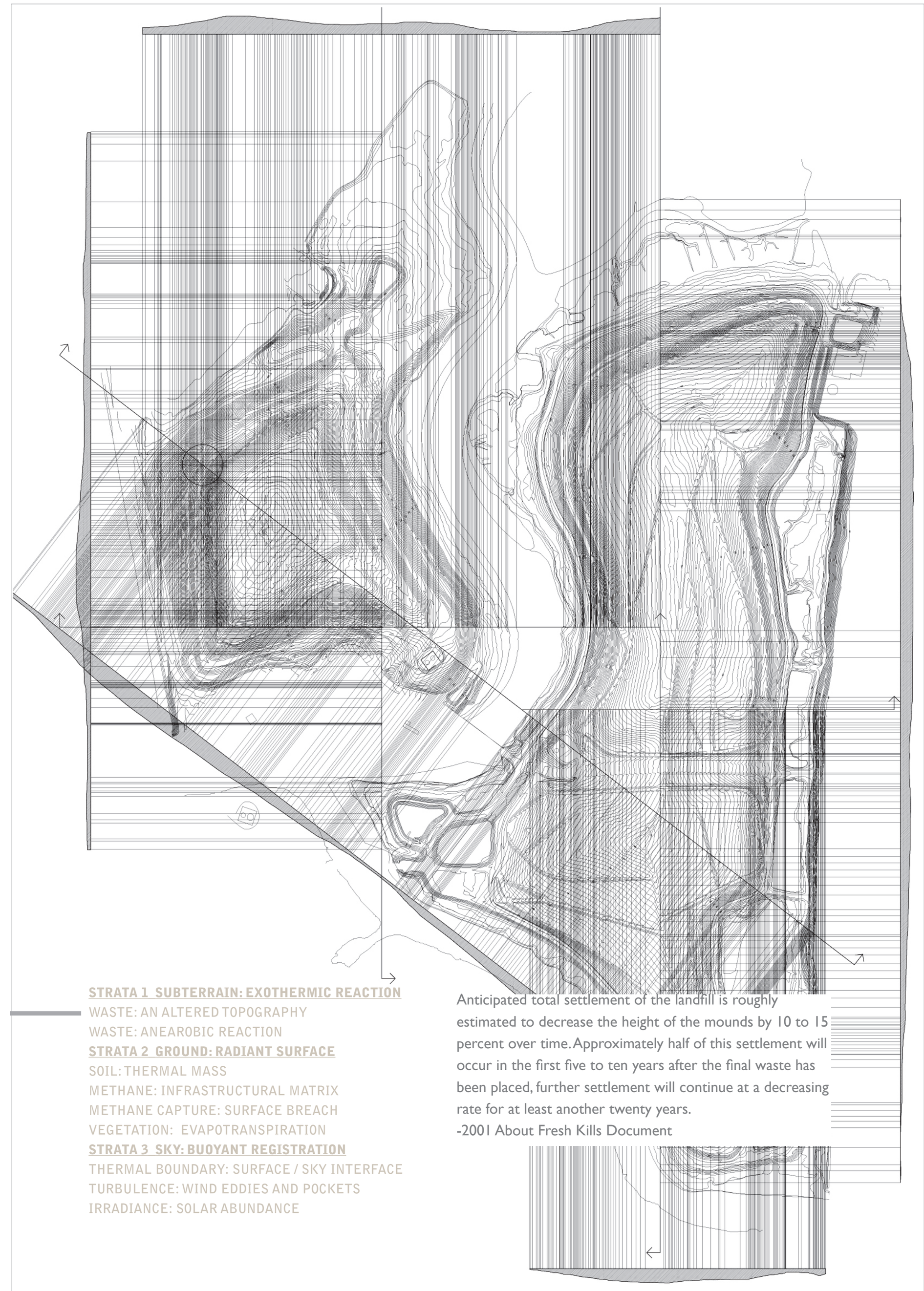

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Anticipated total settlement of the landfill is roughly estimated to decrease the height of the mounds by 10 to 15 percent over time. Approximately half of this settlement will occur in the first five to ten years after the final waste has been placed, further settlement will continue at a decreasing rate for at least another twenty years.
-2001 About Fresh Kills Document

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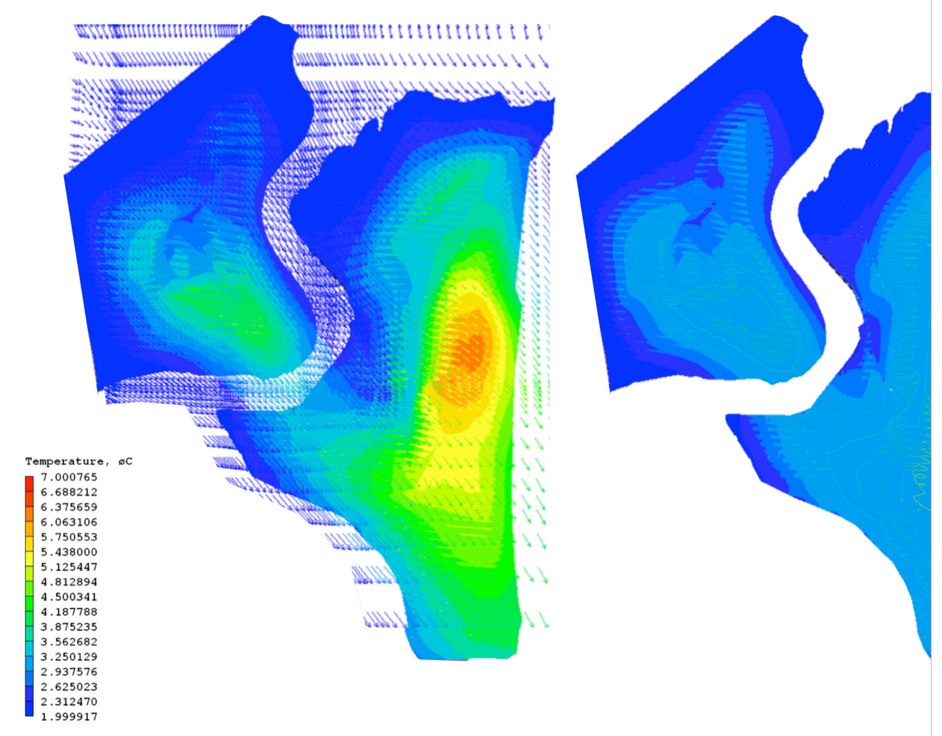
However, there are two points to note about landfills in general, and Section 6/7-East Park – in particular. They are: (1) landfill soils have thermal subsidy, that is, higher than normal temperatures of 140F (60C) or higher; and (2) Section 6/7 has excellent draining material, which means that the soils have the best chance to drain before the water can freeze.
-Q+A document (New York City Dept of Sanitation)

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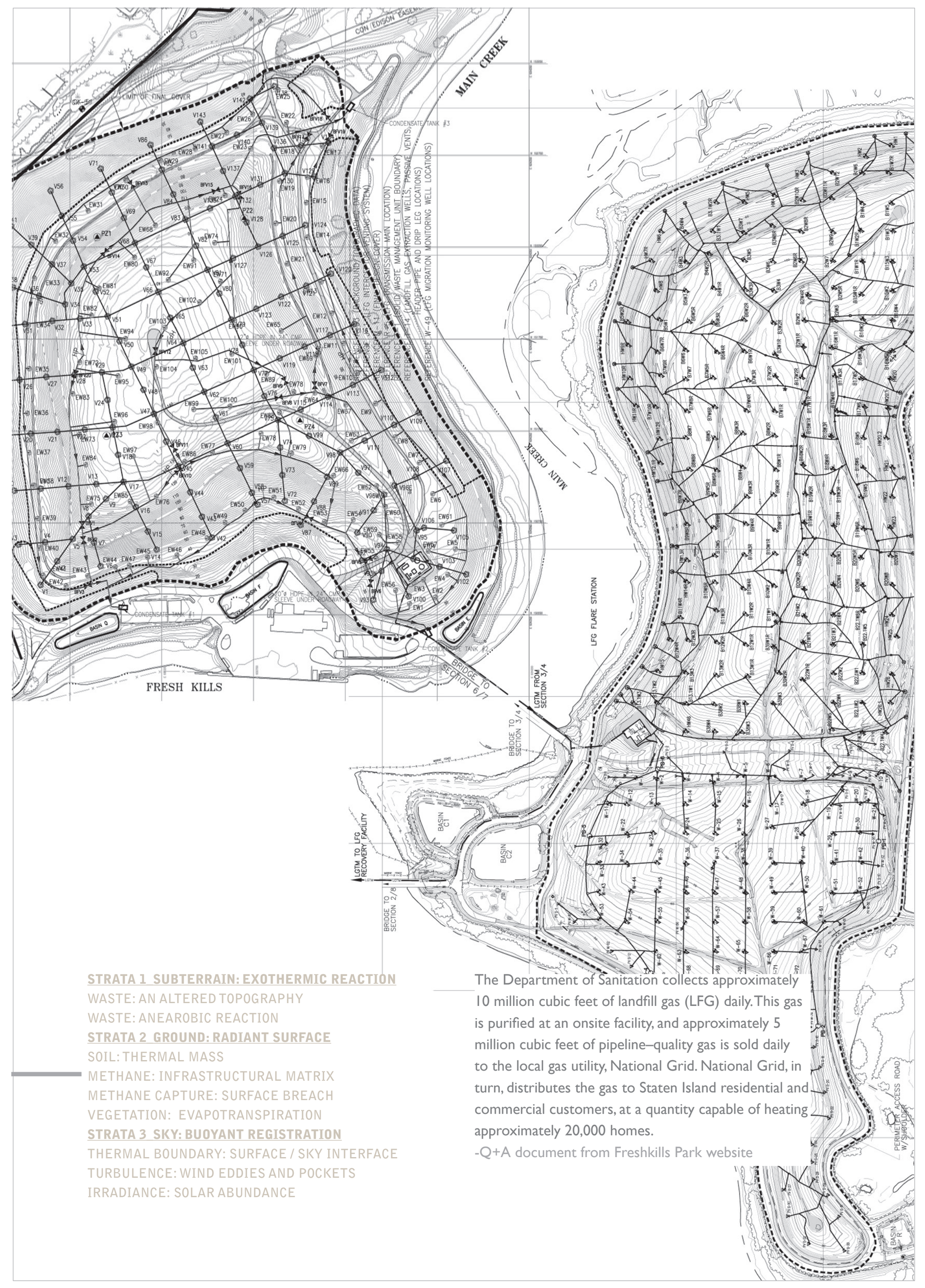
Left image: Computational Fluid Dynamics model of the site on December 21 at 9am assuming a northwesterly wind. The temperature range is a function of heat flux from the soil, which creates distinct pockets of significantly warmer temperatures on the central portion of the mounds.
Right image: Diagrammatically indicates the temperature range of the site without the soil heat flux.



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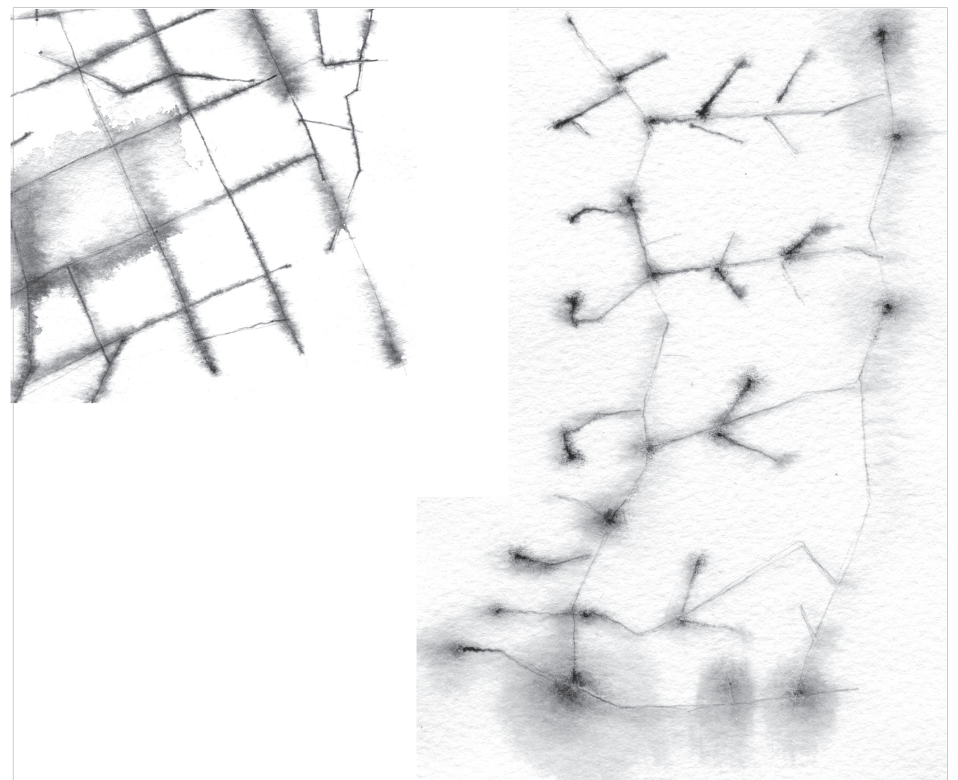
The Department of Sanitation collects approximately 10 million cubic feet of landfill gas (LFG) daily. This gas is purified at an onsite facility, and approximately 5 million cubic feet of pipeline–quality gas is sold daily to the local gas utility, National Grid. National Grid, in turn, distributes the gas to Staten Island residential and commercial customers, at a quantity capable of heating approximately 20,000 homes.
-Q+A document from Freshkills Park website



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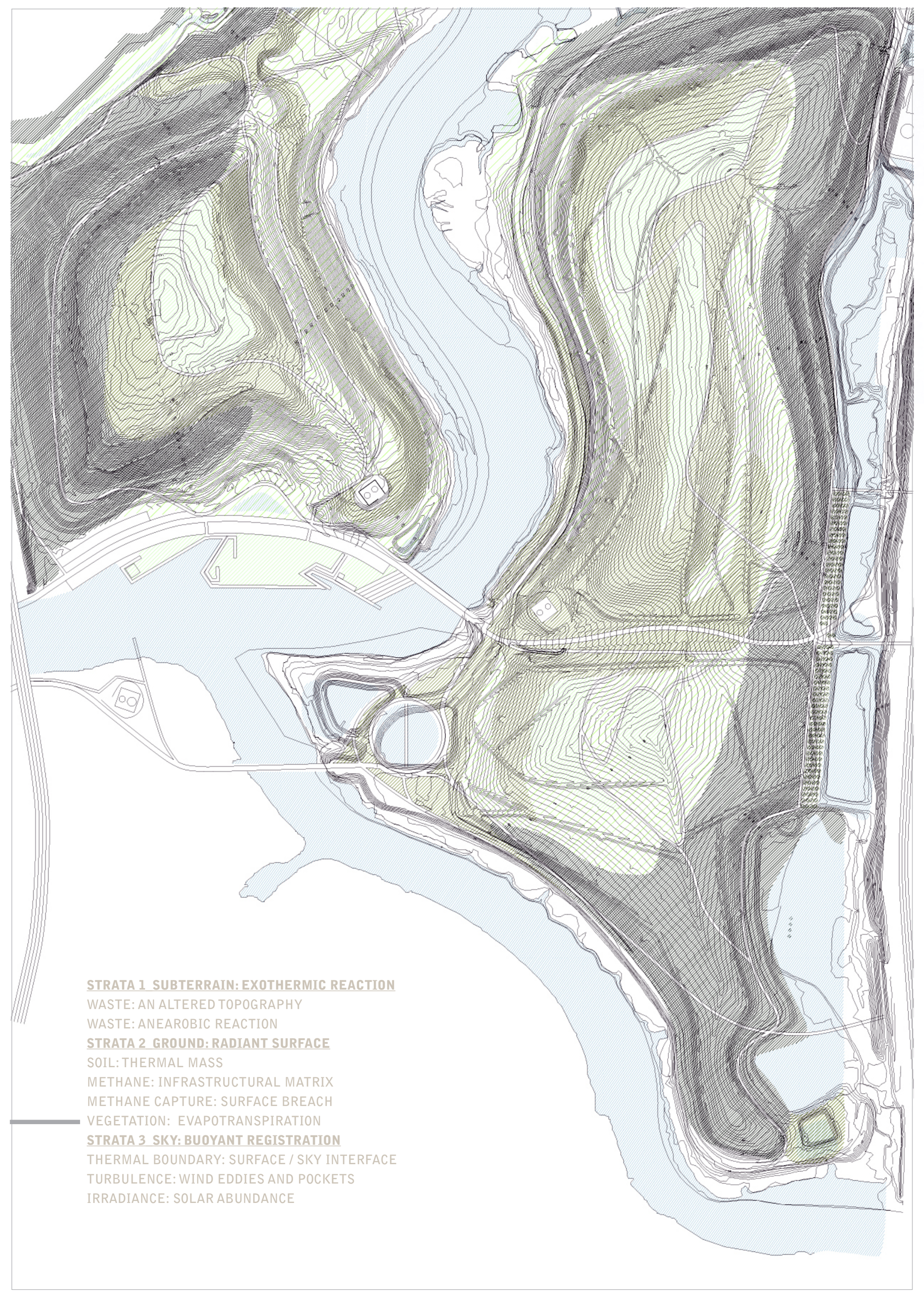

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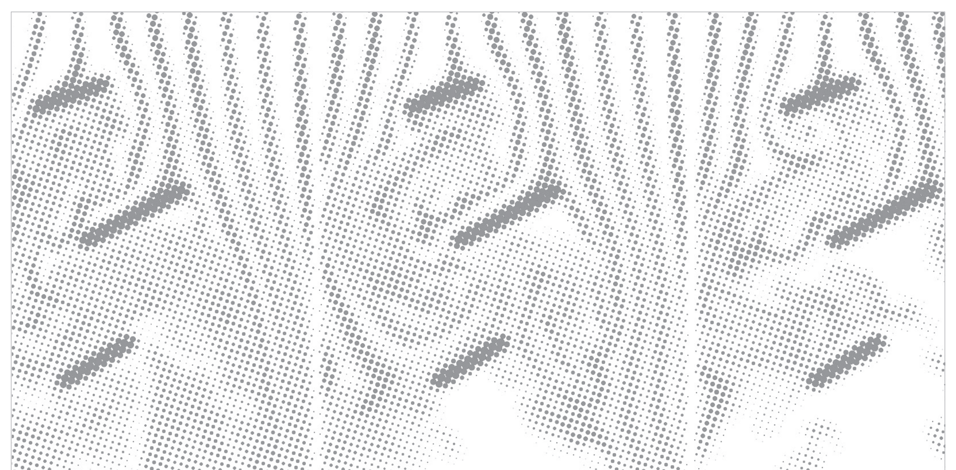

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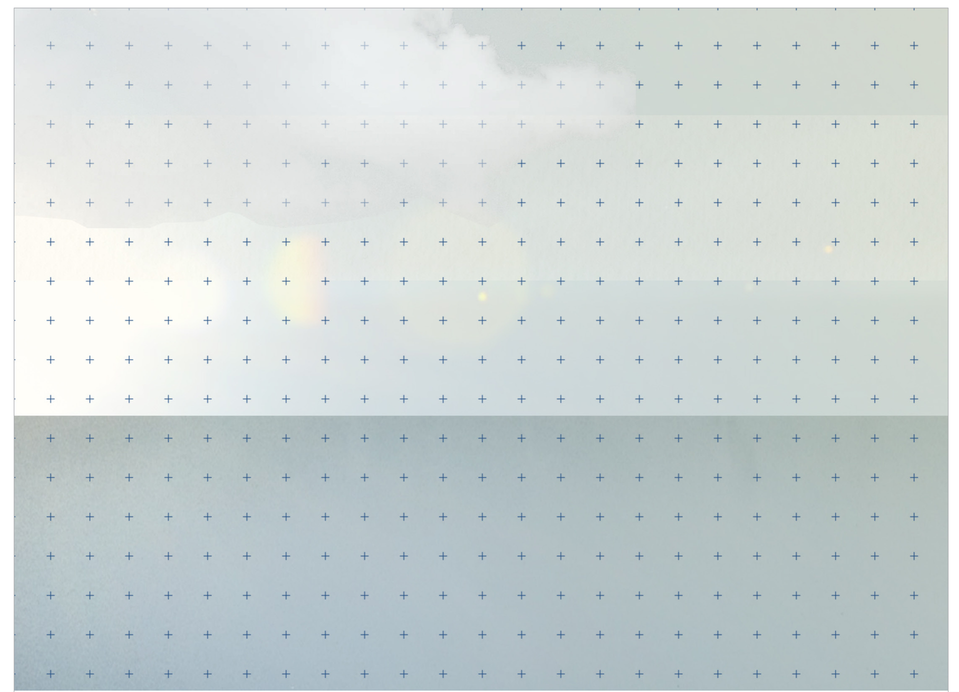
The region's prevailing weather conditions are altered at the landfill because of the topography of the mounds. The steep slopes cause changes in air movements and, depending on their location, act as wind breakers, creating protected pockets, windy tunnels and changing solar exposure. Landfill areas exposed to high levels of sun and/or wind are thus subjected to harsher conditions. These conditions create opportunities and constraints for potential end use and vegetative cover.
-2001 Fresh Kills Competition



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# EXOTHERMIC STRATA

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C EDDY POOLS
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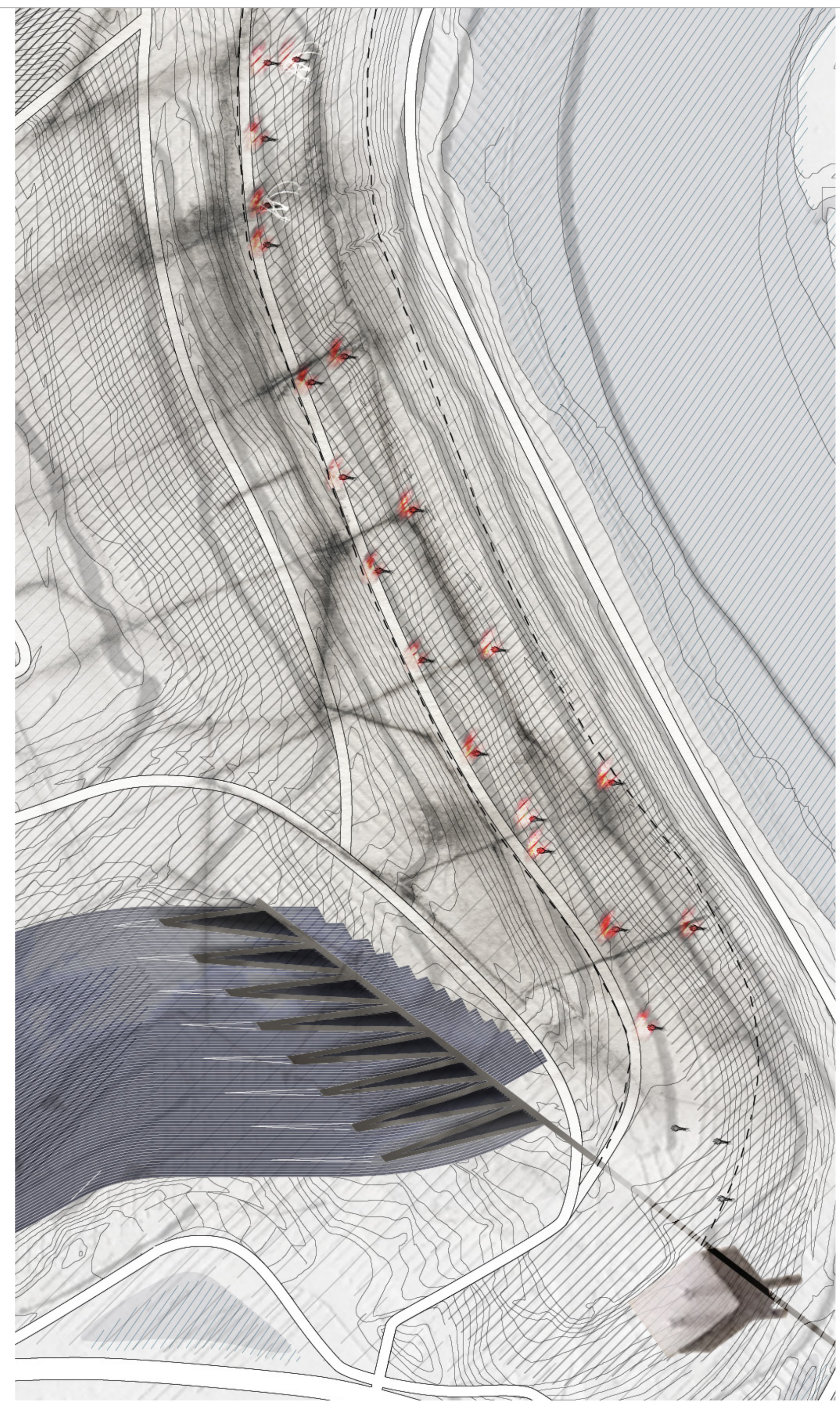
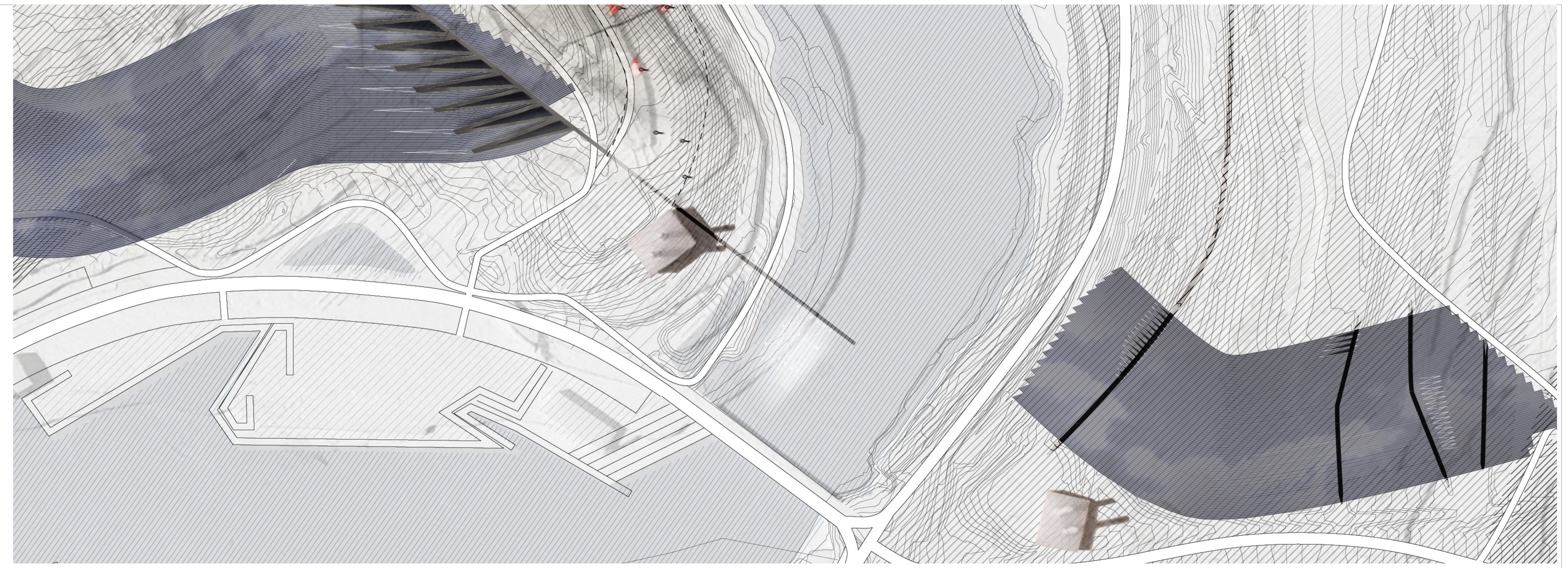
E INCONGRUENT WALK

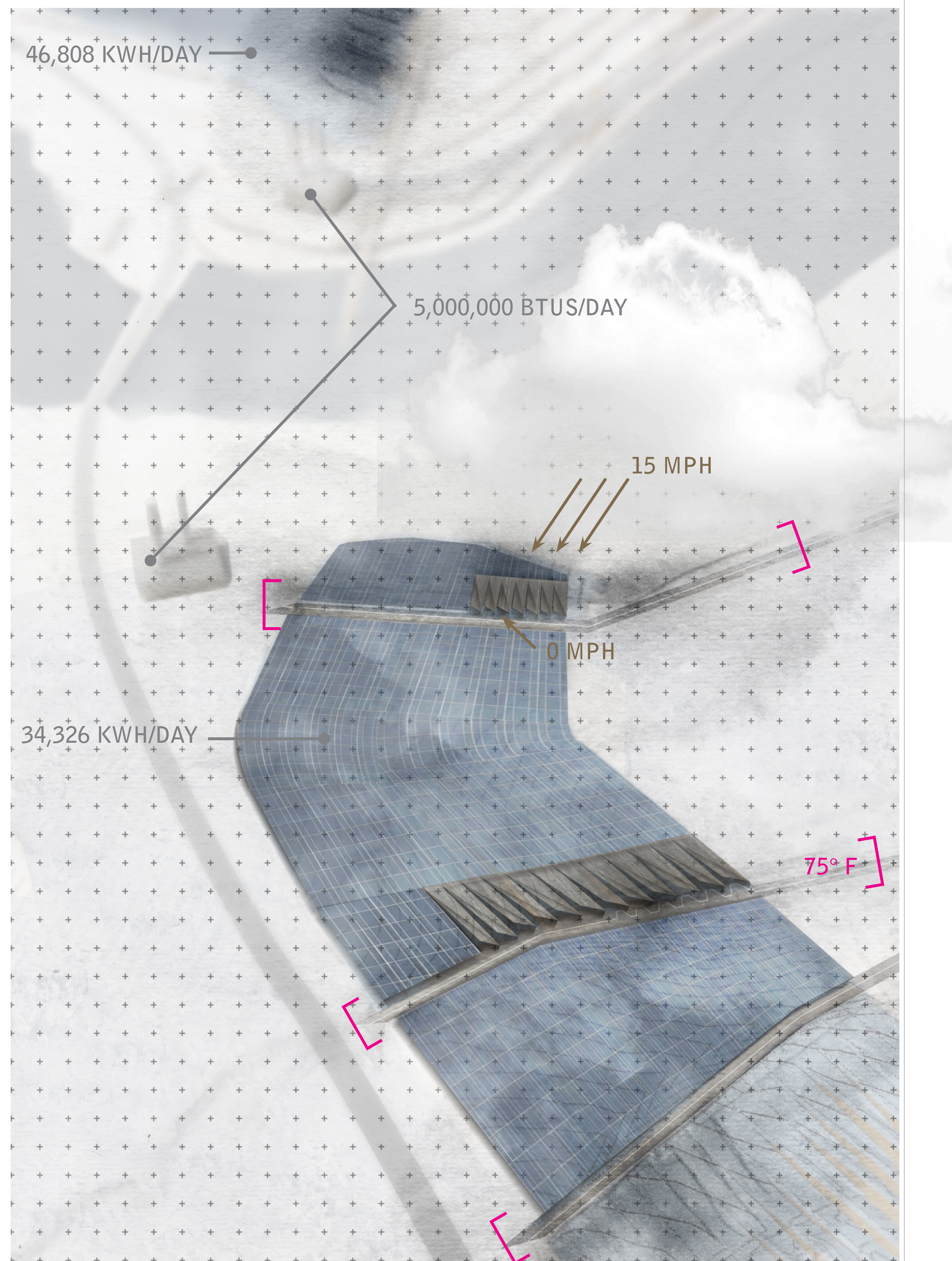




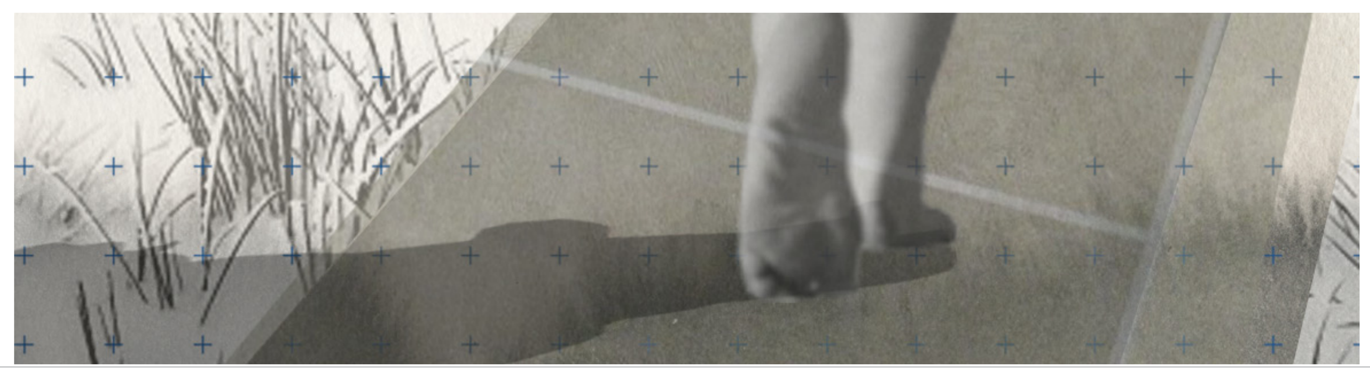
**B RADIANT ROUTE + THE BIG FLARE. HOT MEETS COLD. STILL MEETS SWAY.** The east face of the north mound blocks prevailing northern and northwesterly winter winds, creating a warm pocket during snowy winter days. A series of informal paths follow the lines of methane infrastructure below. Hydronic heated concrete disks adjacent to these paths provide heated surfaces for picnics in winter, acknowledging the heat emitting conditions in the landfill below. Existing methane vents are covered with a perforated steel cages, which provide structural support for steel LED light stalks, which trace the turbulent wind conditions above despite the stillness at ground level.

**A SOLAR FIELD. HOT MEETS COLD:** A crystalline field of lightweight solar film creates a new strata, covering the south faces of the north and east mounds. Covering a total of 55 acres, the solar field generates approximately 28,765,525 kWh per year per year, enough electricity to power approximately 3,930 homes. Walking paths bisect the field. Adjacent to these paths, the surface peels up, revealing a black rubberized membrane that absorbs low winter sun. The angle of the surface breaks northwesterly winter winds, creating a warm winter microclimate.

**E INCONGRUENT WALK:** A series of concrete paths follow existing drainage channels on the east mound, cutting through the solar field. The smooth paths contain a central channel that directs water flow down and to a series of warm wading pools. The surface is heated in the winter, inviting bare feet strolls.







# THERMAL WALK / THE BIG FLARE + SOLAR FIELD

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**THERMAL EVENTS**

A SOLAR FIELD

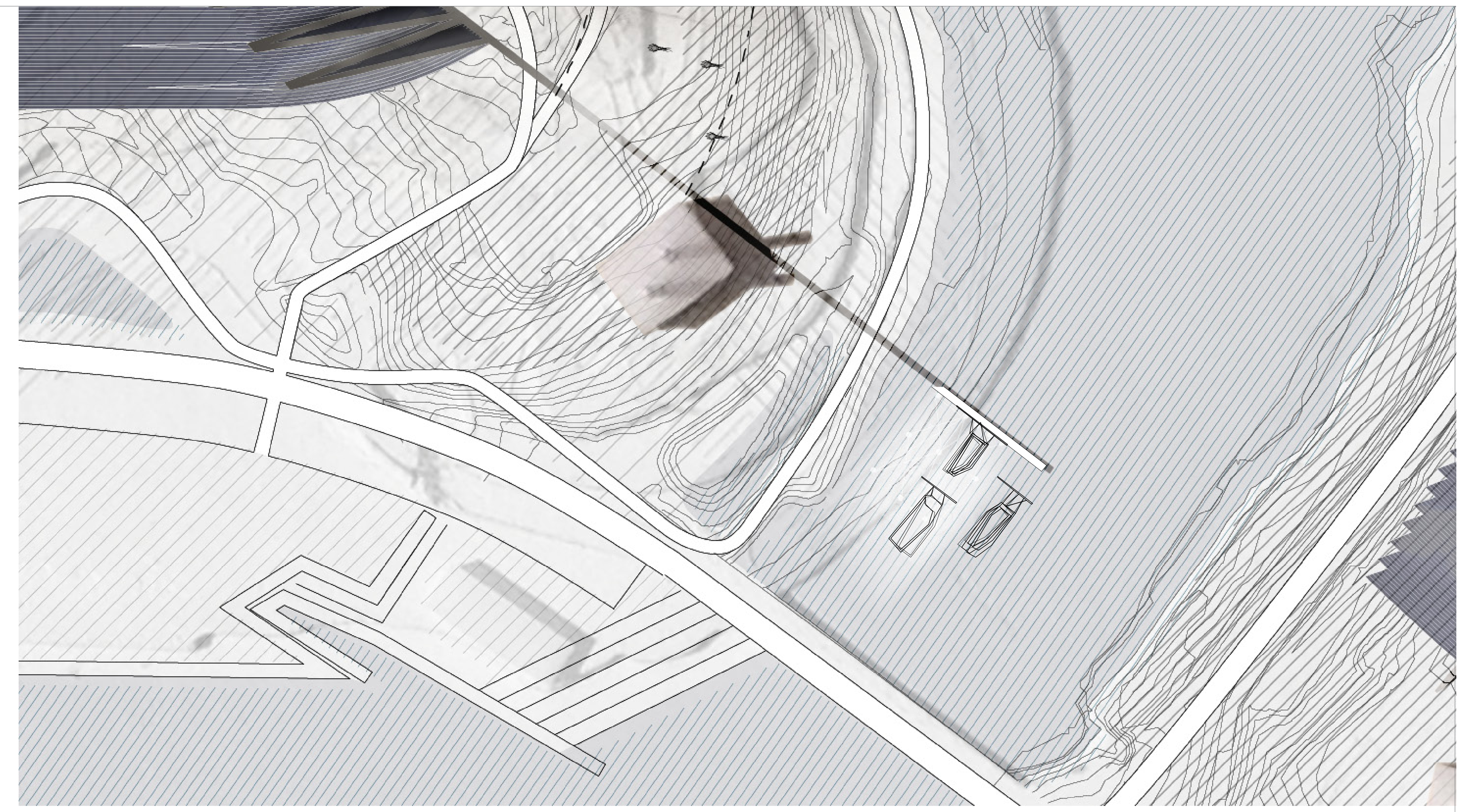
B RADIANT ROUTE + THE BIG FLARE

C EDDY POOLS

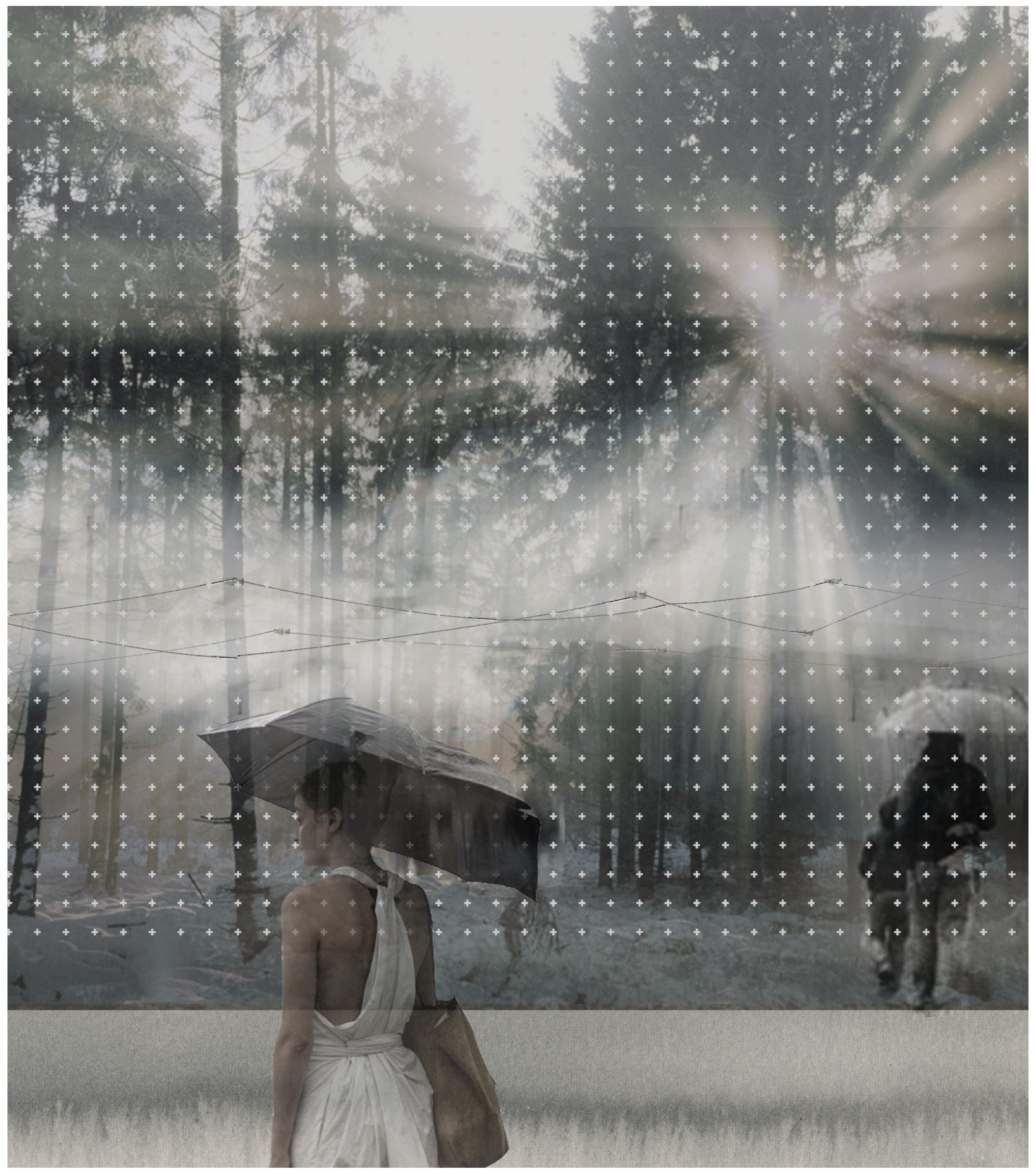
D WOODLAND BLUR

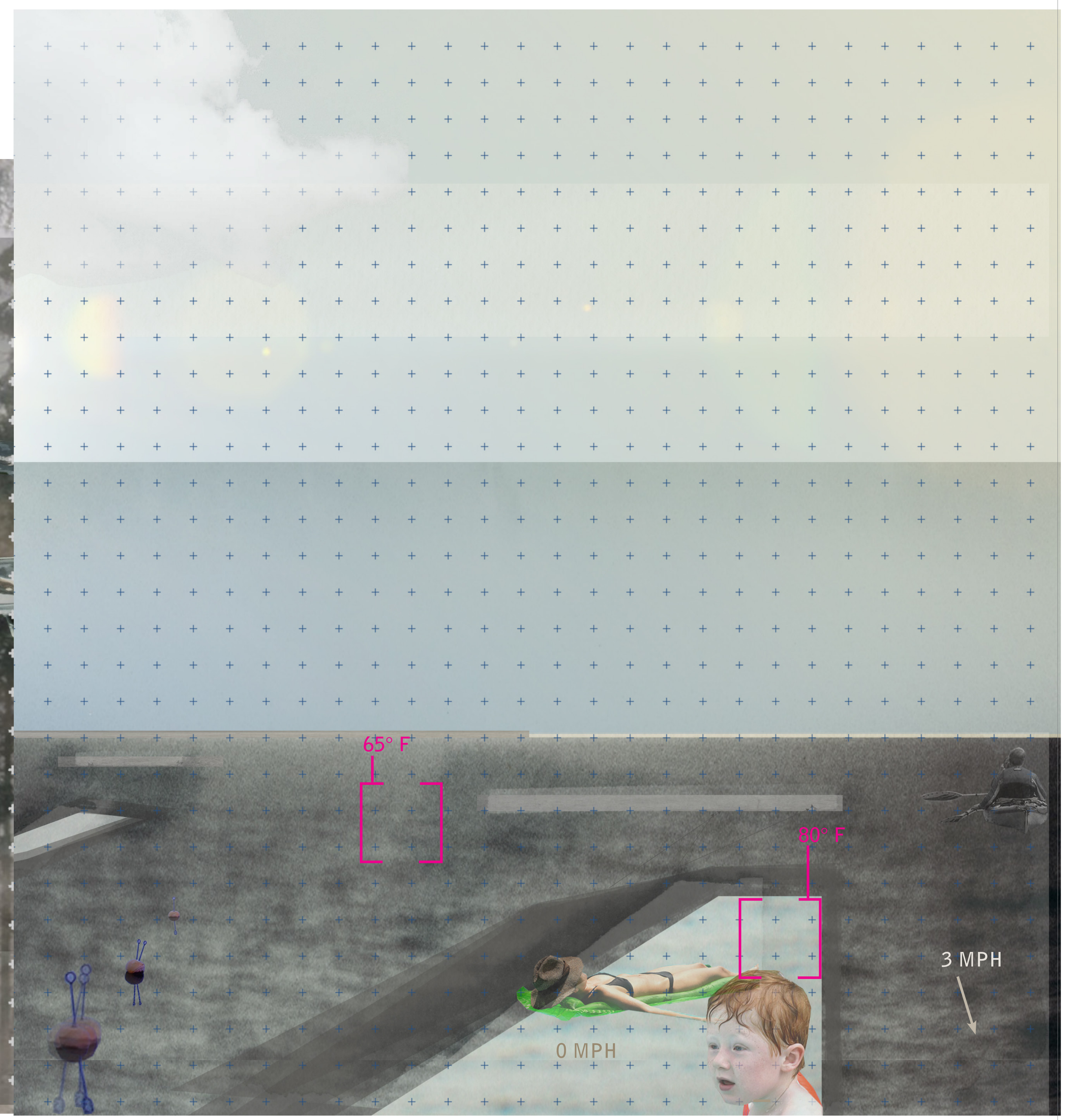
E INCONGRUENT WALK

**D WOODLAND BLUR: BLUR MEETS CLEAR** Steel cables are strung between collars attached to trees in the north mound west woodland. In summer, water nozzles shoot atomised water, creating a hovering misty shroud within the grove. This water, combined with vegetative evapotranspiration, provide a cool refuge from the summer heat and exposure on the rest of the site.



**C EDDY POOLS: CALM MEETS TURBULENCE** A series of black heat absorbing buoyant pools in Freshkills Creek are tethered to concrete wall supports. The anchor walls are oriented perpendicular to the current, generating small scale eddies and vortices in the cool stream between the wall and warm pools.






# WOODLAND BLUR + EDDY POOLS

**FRESHKILLS EXOTHERMIC LANDSCAPE**
**Lisa Moffitt, ESALA**
**Collaborators: Dr. Fan Wang, Heriot Watt University**
**Alistair Patterson, Heriot Watt University**

The Freshkills Exothermic Landscape visually and experientially registers the thermal subterranean, ground level and aerial topographies of the constructed landscape of Freshkills park. These strata include the following: the exothermic conditions of subterranean decomposition; infrastructure associated with methane collection, venting and flaring; topographic mounds that channel wind over, around and in between; the heat absorbing vegetative cap. The proposal, a toolkit of site specific interventions, strategically harvests and amplifies the energetic conditions of each strata, generating electricity, making existing methane production on site visible, and activating a series of thermal events.

The thermal events, unexpected moments of thermal incongruence, draw from distinct microclimate conditions of the constructed topography and heat emitting surface of the landfill. Here, unexpected experiential interfaces emerge. Hot meets cold. Blur meets clear. Static meets sway. Turbulence meets calm.

**RENEWABLE ENERGY STATEMENT**

Optimally sloped for solar collection, a new strata is added to the south face of the north and east mound. Composed of lightweight PV laminates, this new strata is slightly raised from, while still conforming to the existing topography. Due to the lightweight nature of the laminate, no additional invasive foundational support is required. The selected system, Unisolar Power Bond, has the best watts per pound performance of any solar system according to Sampson (2009). The north mound consists of 19 acres in plan (30 surface acres, taking topography into account); the east mound consists of 15 acres in plan (22 surface acres). Both surfaces combined yield approximately enough electricity to power almost 4000 homes.

**Installation Area**
(30 acres + 22 acres) 52 acres = **2,265,120 ft2**

**PV Laminate Specs**
Unisolar Power Bond ePVL144 Source: http://www.uni-solar.com/products/commercial-products/pvl/
Maximum Power 144W
Maximum Voltage 33V
Size: 213.1" x 14.69" = 2982 in2 = 20.7ft2
144W / 20.1 ft2= **6.96 w/ft 2**

**KW Generated on Site**
6.96 w/sf x 2,265,120ft2=15,757,360 W= **15,757KW**
15757KW x 5 hr/day x 365 days= **28,765,525 kWh per year**

**Electricity Consumption in New York Households**
New York Average Monthly Electricity Consumption/household/month: 610 kWh/month x 12 months= **7,320 kWh (**Source: US Energy Information)
28,765,525 KWh / 7320 KWh = **3930 homes assuming existing per capita electricity consumption in New York State.**

**SITE PLAN INDICATING MICROCLIMATE ZONES**
Page 2

**COMPUTATIONAL FLUID DYNAMIC ANALYSIS OF SITE**
Pages 3-10

**EFFECTIVE TEMPERATURE CALCULATIONS**
Pages 11-12

SITE C: FOREST MIST

JUNE 21 12:00 pm
SURFACE: GRASS
RADIATION: FULL SHADE (UNDER FOREST CANOPY)
WIND: (PER WIND DATA)
TEMP: (PER TEMP DATA)
EVAPORATIVE COOLING: FROM VEGETATION AND FROM ADDITIONAL WATER MIST
EFFECTIVE TEMP:

SITE B: RADIANT ROUTE

OCTOBER 21 12 PM
SURFACE: CONCRETE WITH THERMAL GAIN FROM SOIL
RADIATION: FULL SUN
WIND: PER WIND DATA
TEMP: (PER TEMP DATA)
EFFECTIVE TEMP:

DECEMBER 21 12 PM
SURFACE: CONCRETE WITH THERMAL GAIN FROM SOIL
RADIATION: FULL SUN
WIND: PER WIND DATA
TEMP: (PER TEMP DATA)
EFFECTIVE TEMP:

SITE A: SOLAR FIELD

JUNE 21 12:00 pm
SURFACE: WOOD DECKING (OFF GRADE, SO NOT ABSORBING HEAT FROM SOIL)
RADIATION: FULL SHADE UNDER CANOPY
WIND: (PER WIND DATA)
TEMP: (PER TEMP DATA)
EFFECTIVE TEMP:

DECEMBER 21 12:00 PM
SURFACE: TARMAC- ASSUME THERMAL GAIN FROM SOIL
RADIATION: FULL SUN
WIND: NONE
TEMP: (PER TEMP DATA)
EFFECTIVE TEMP:

SITE D: EDDY POOLS

JUNE 21 12:00 pm
SURFACE: SITTING IN WATER (TEMP 18 C)
RADIATION: FULL SUN
WIND: (PER WIND DATA)
TEMP: (PER TEMP DATA)
EFFECTIVE TEMP:

SITE F: THERMAL INCONGRUENCE CHANNELS

JUNE 21 12:00 pm
SURFACE: CONCRETE WITH FEET IN COLD WATER
RADIATION: FULL SUN
WIND: (PER WIND DATA)
TEMP: (PER TEMP DATA)
EFFECTIVE TEMP:

DEC 21 12:00 pm
SURFACE: CONCRETE WITH FEET IN HOT WATER
RADIATION: FULL SUN
WIND: (PER WIND DATA)
TEMP: (PER TEMP DATA)
EFFECTIVE TEMP:

SITE E: THERMAL INCONGRUENCE CHANNELS

JUNE 21 12:00 pm
SURFACE: CONCRETE WITH FEET IN COLD WATER
RADIATION: FULL SUN
WIND: (PER WIND DATA)
TEMP: (PER TEMP DATA)
EFFECTIVE TEMP:

DEC 21 12:00 pm
SURFACE: CONCRETE WITH FEET IN WARM WATER
RADIATION: FULL SUN
WIND: (PER WIND DATA)
TEMP: (PER TEMP DATA)
EFFECTIVE TEMP:

CONTROL SITE B (AVERAGE WINTER CONDITIONS)

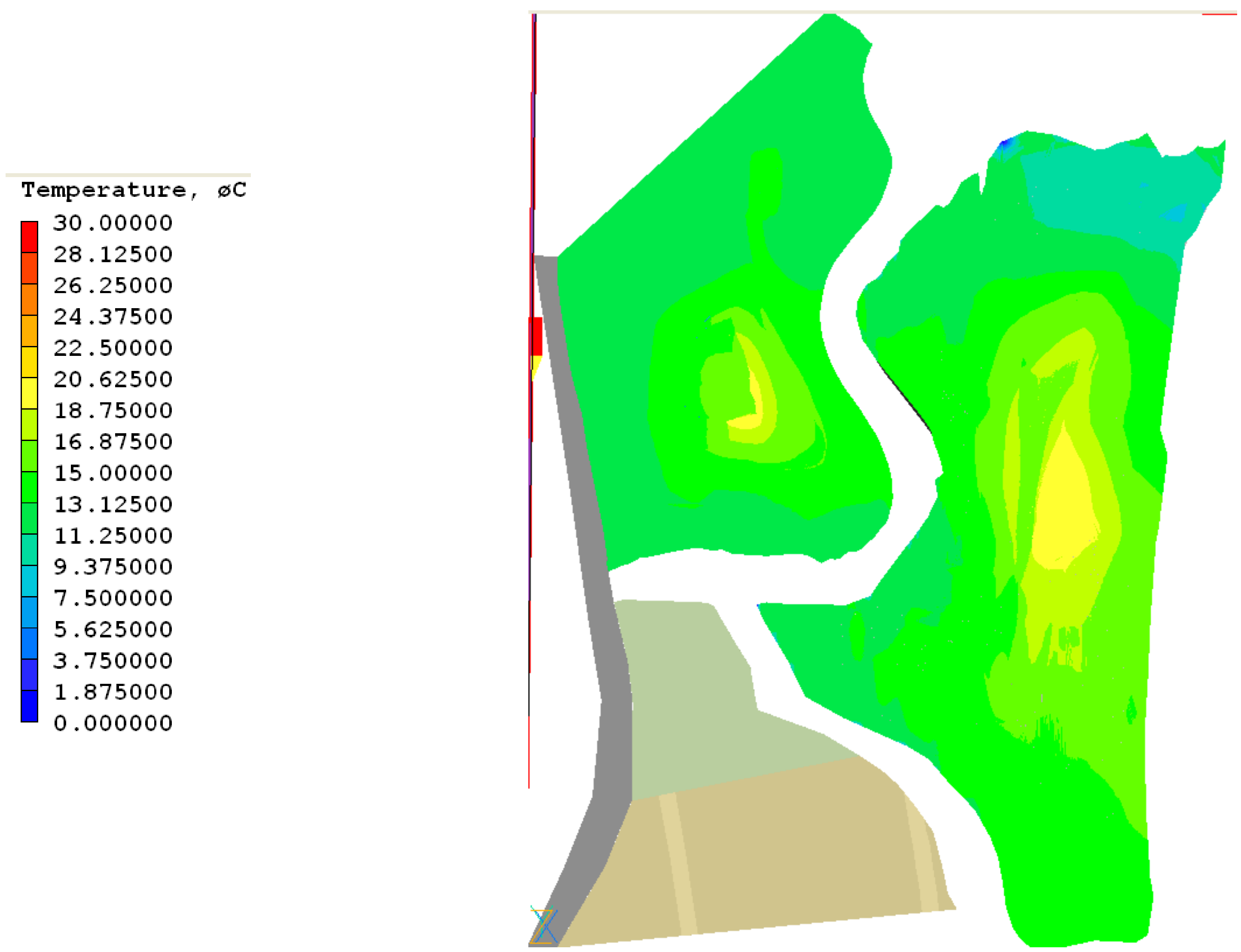
JUNE 21 12:00 pm
SURFACE: LAWN
RADIATION: CLOUDY
WIND: (PER WIND DATA)
TEMP: (PER TEMP DATA)
EFFECTIVE TEMP:

CONTROL SITE A (AVERAGE SUMMER CONDITIONS)

JUNE 21 12:00 pm
SURFACE: LAWN
RADIATION: FULL SUN
WIND: (PER WIND DATA)
TEMP: (PER TEMP DATA)
EFFECTIVE TEMP:

Spring/ Autumn – Wind profile 5 m/s from NW @13°C

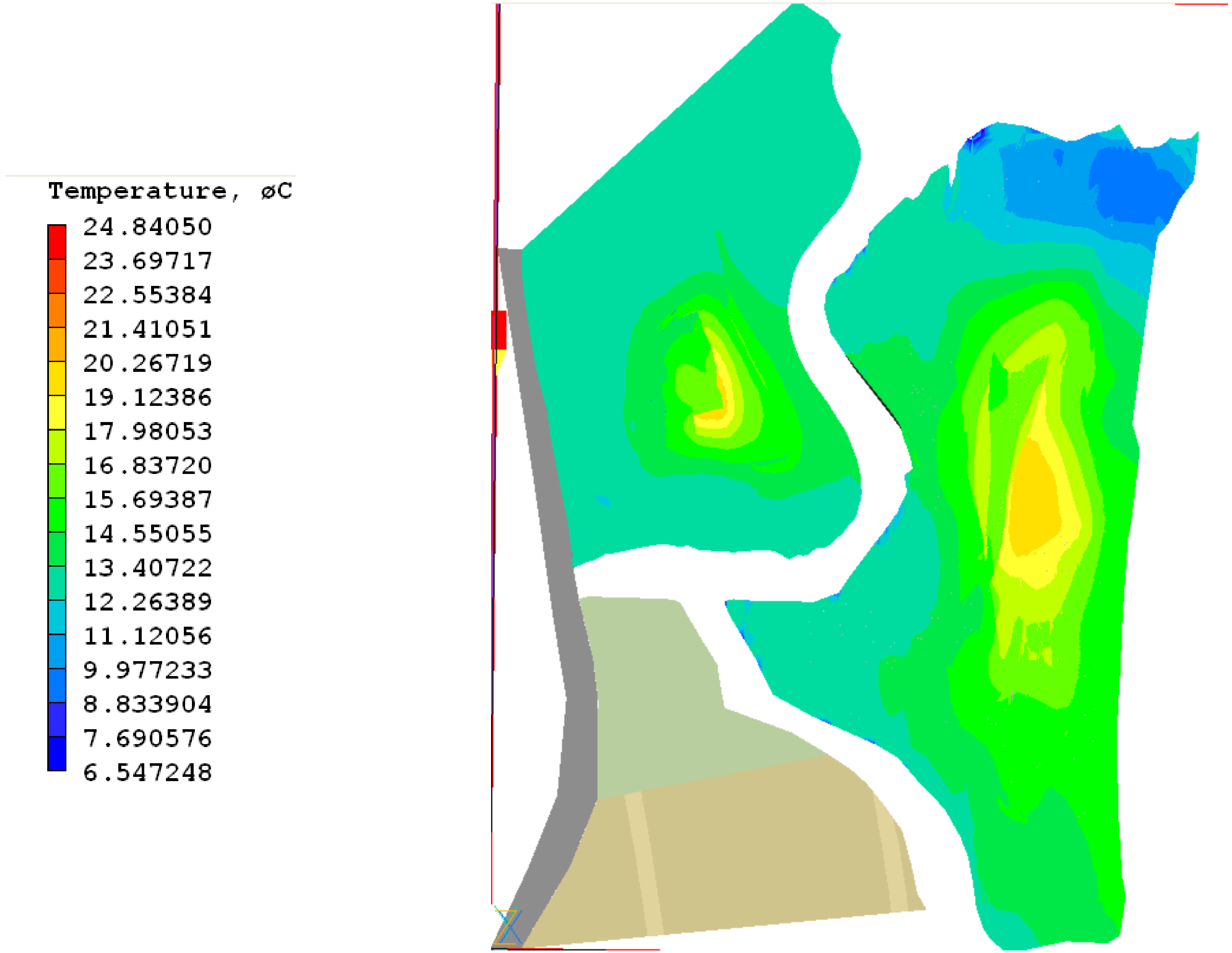
Temperature




This scenario for autumn and spring includes both the landfill generation and also absorption from the vegetation as in spring especially, there will be significant evapotranspiration.

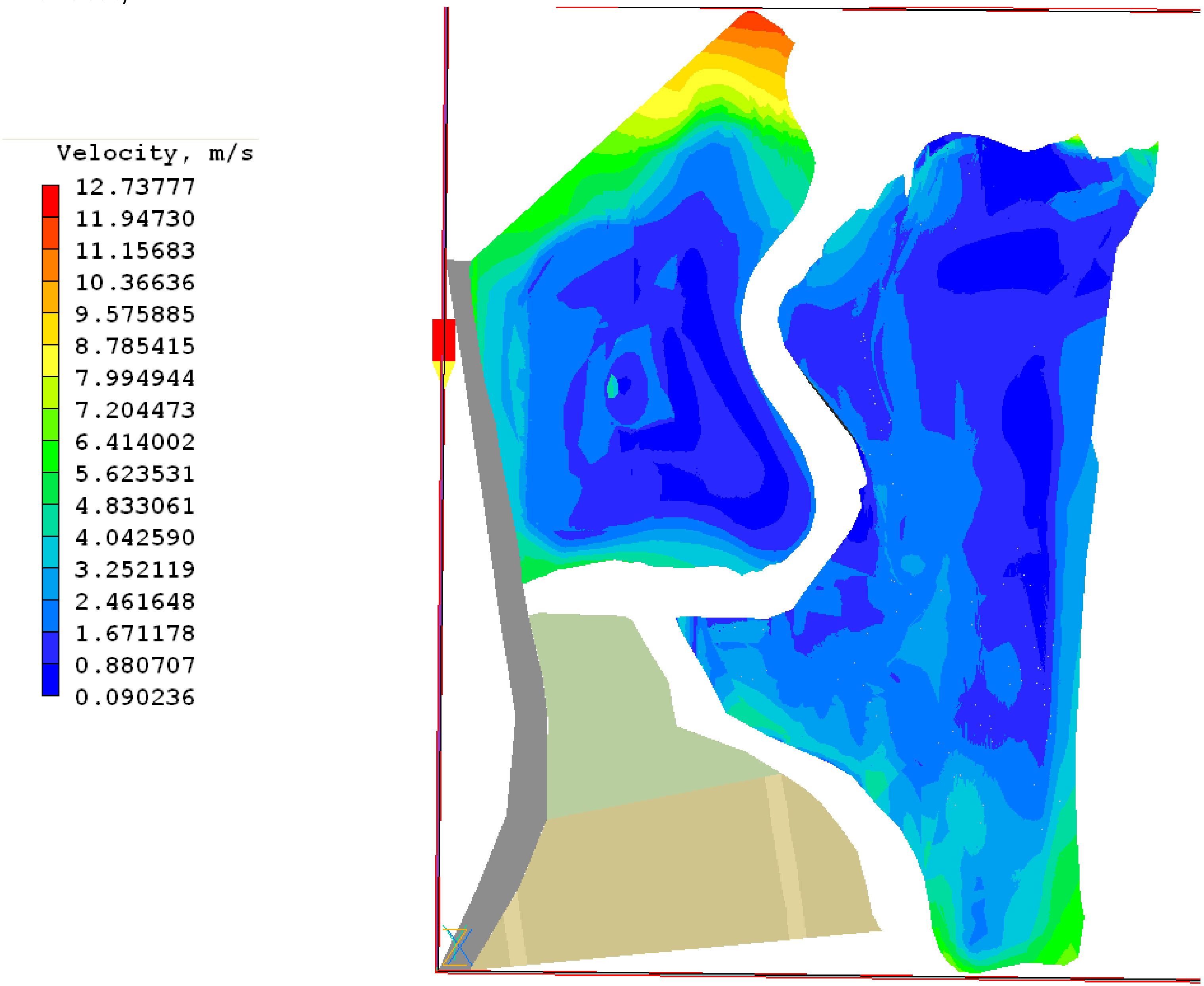
Spring/ Autumn – Wind profile 5 m/s from NW @13°C

Temperature



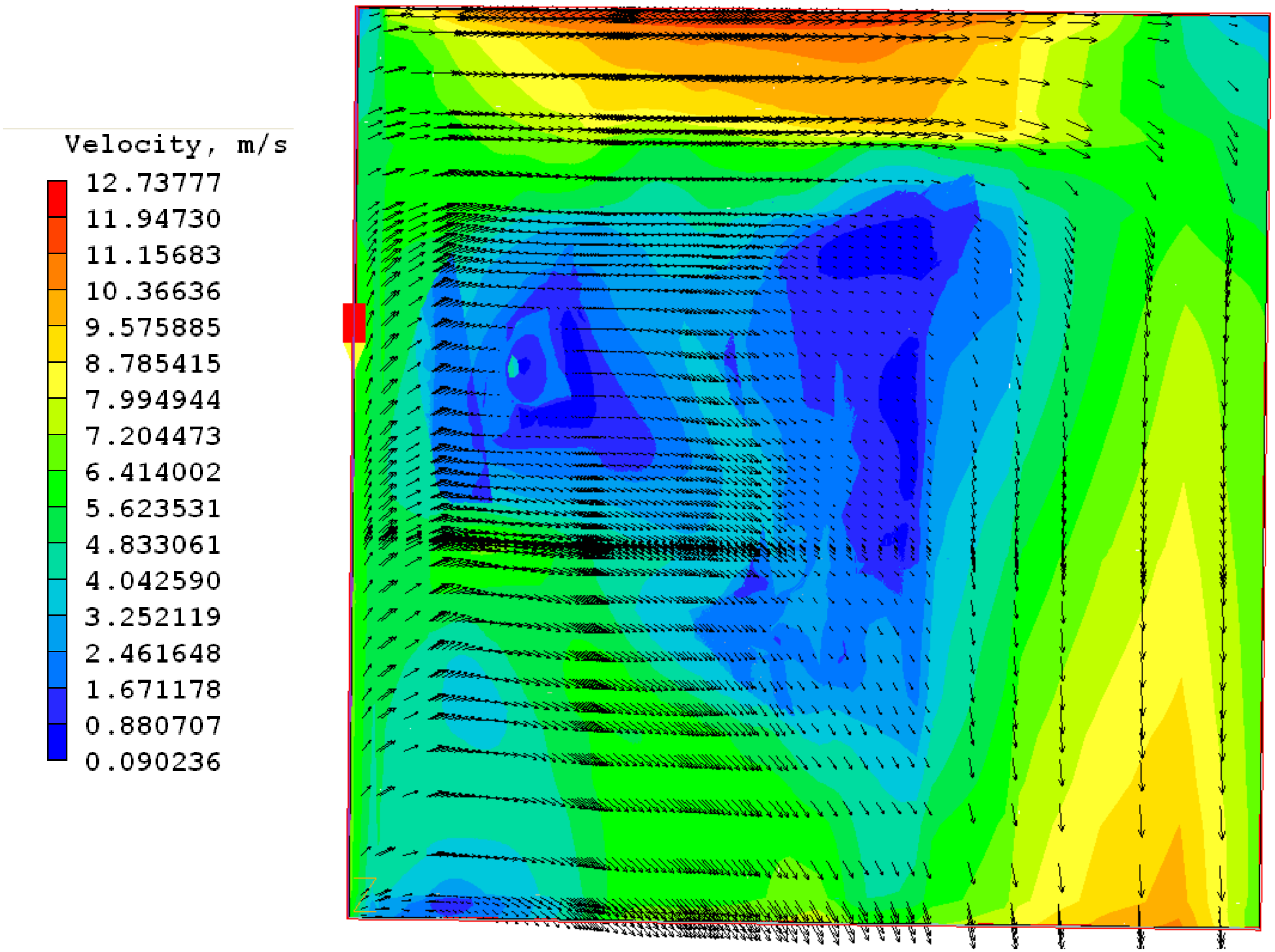
Spring/ Autumn – Wind profile 5 m/s from NW @13°C

Wind Velocity



Spring/ Autumn – Wind profile 5 m/s from NW @13°C

Wind Velocity and Direction. Grid plane section at 20m above ground level



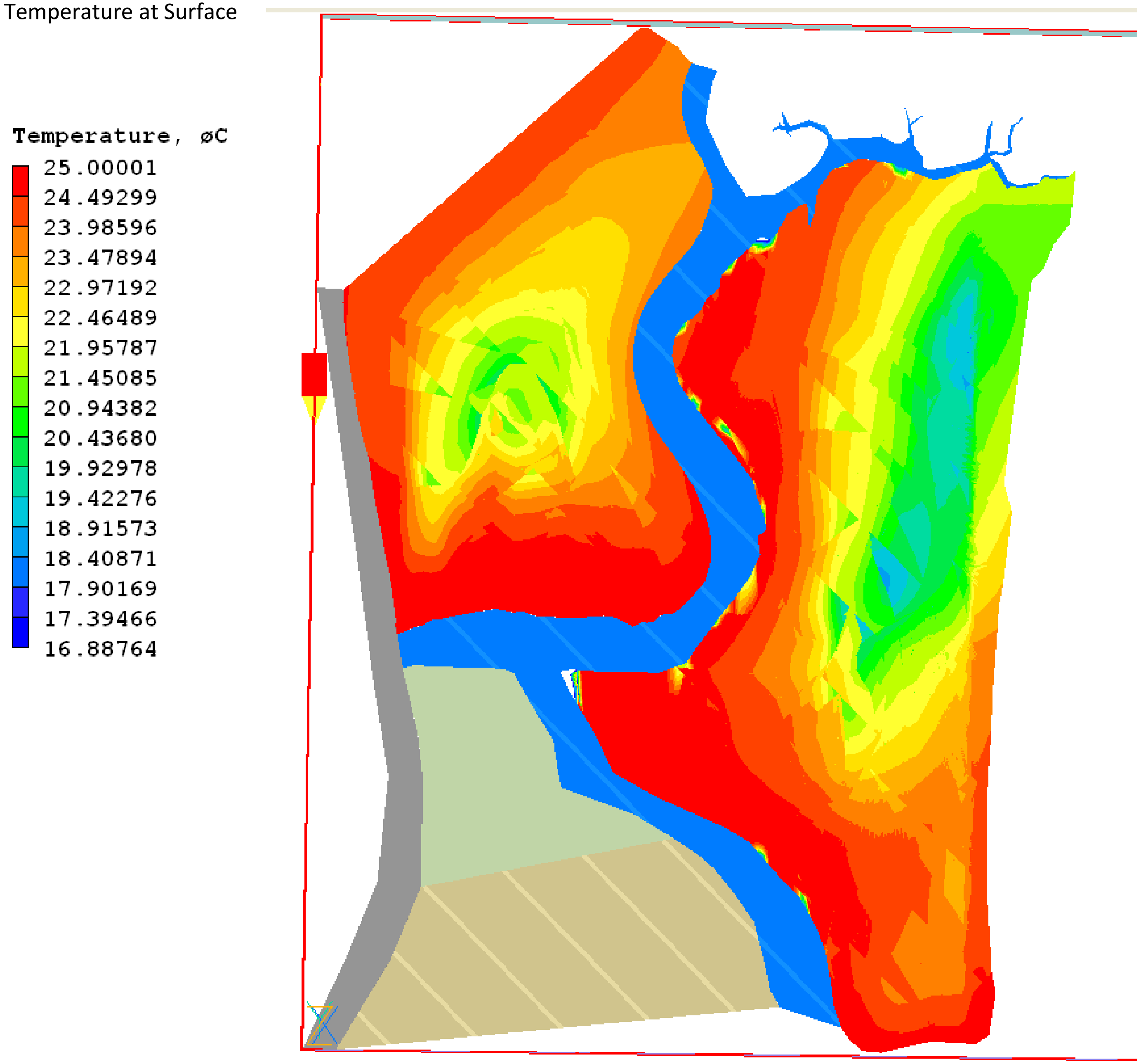

I found it difficult to get a north westerly wind working on CFD.

That said, from the weather data, I found that in both spring and in autumn the wind is pretty changeable, unlike the prevailing winds in sinter (west) and summer (south).

For example in September there is significant wind from the north but in November, there is very little, but prevailing winds from West/ south West

Summer Morning – Wind profile 5 m/s from South @25°C

Air Temperature at Surface

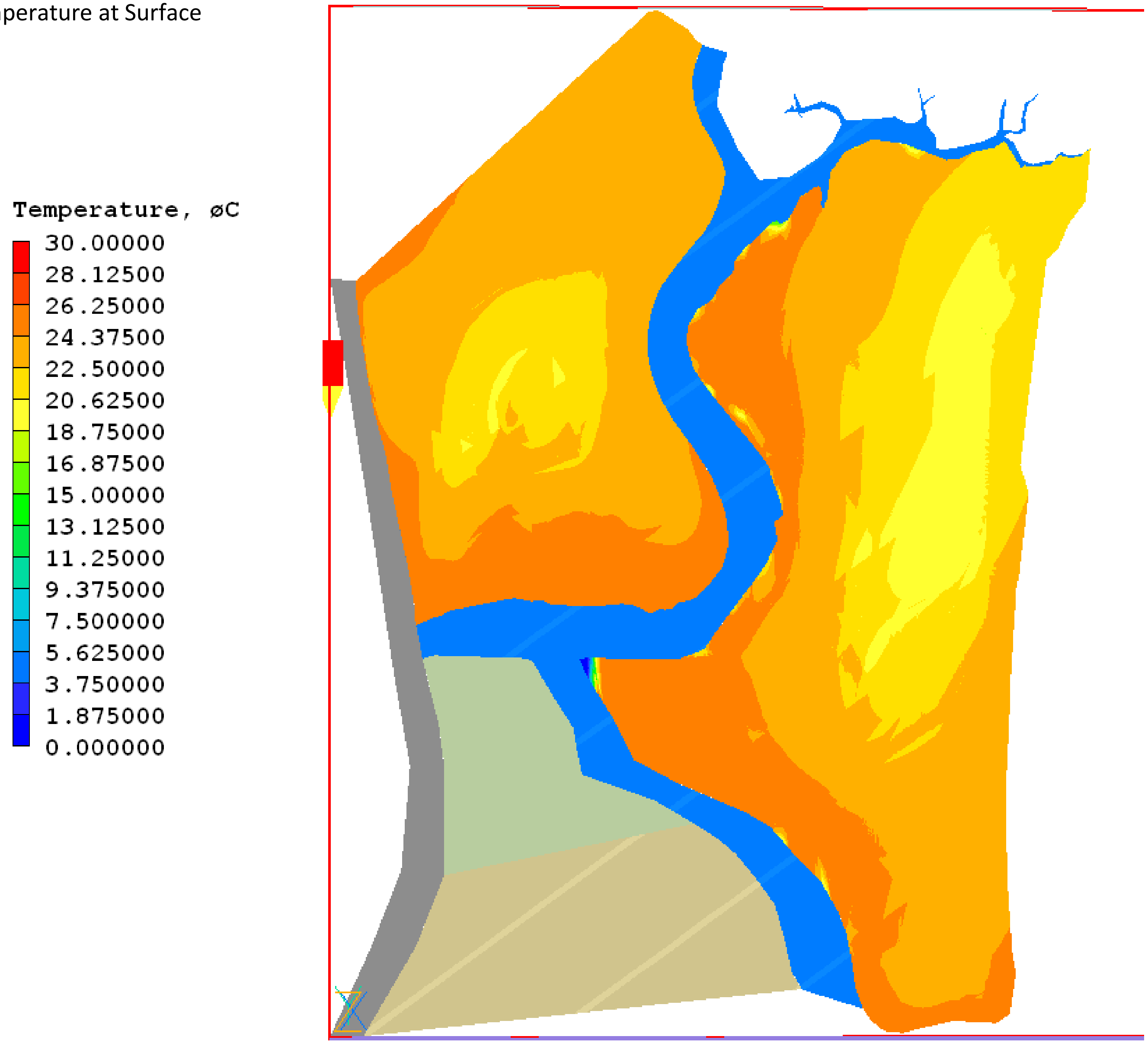



The vegetation can significantly reduce air temperatures through evapotranspiration.

These are safe assumptions based on literature, crop coefficients, and the evapotranspiration rate for Freshkills to get a safe estimation of how much latent heat will be absorbed.

Summer– Wind profile 5 m/s from S @25°C

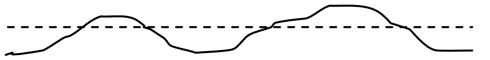
Air Temperature at Surface

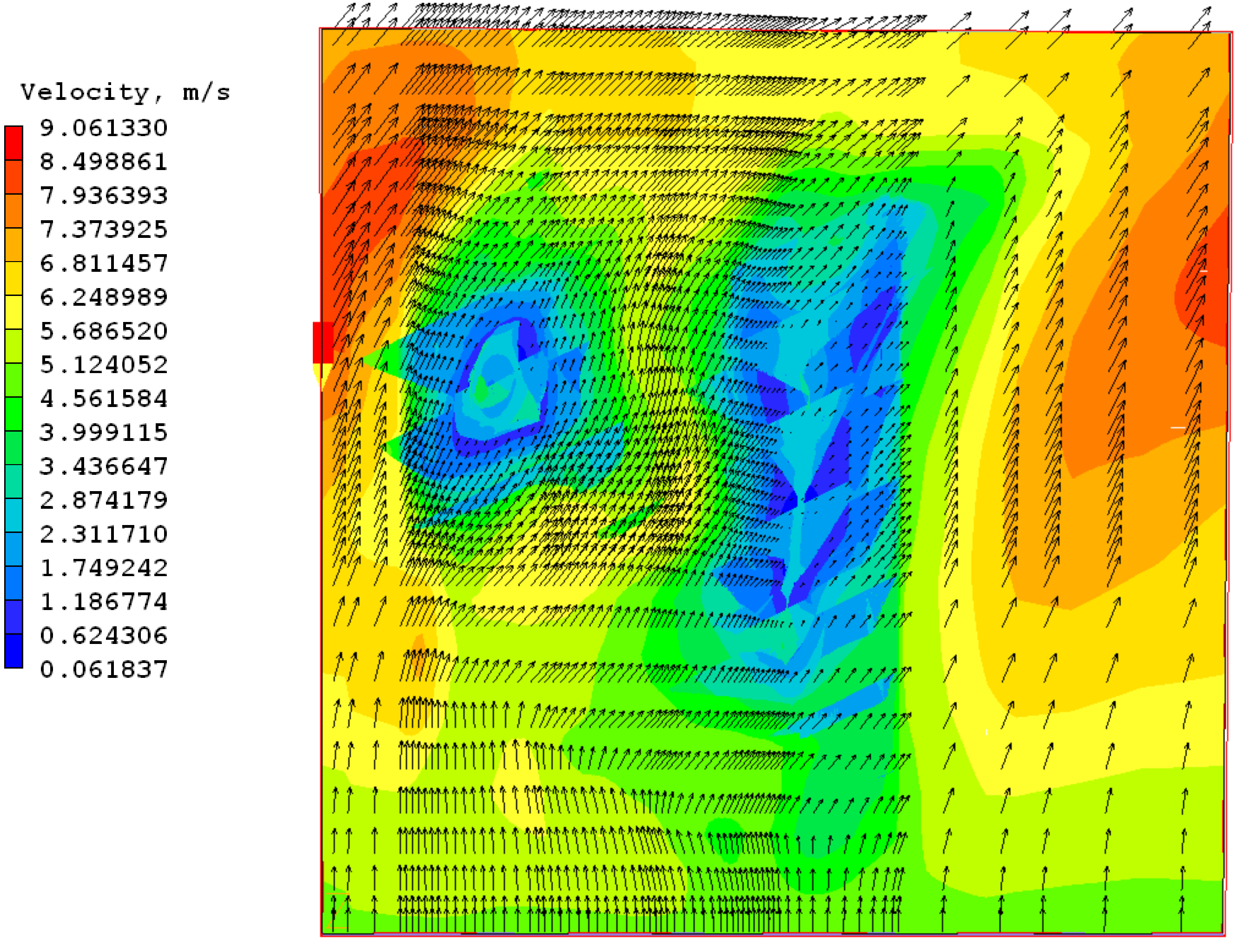



The summer air temperatures will be around 24 to 28°C

Summer – Wind profile 5 m/s from S @25°C

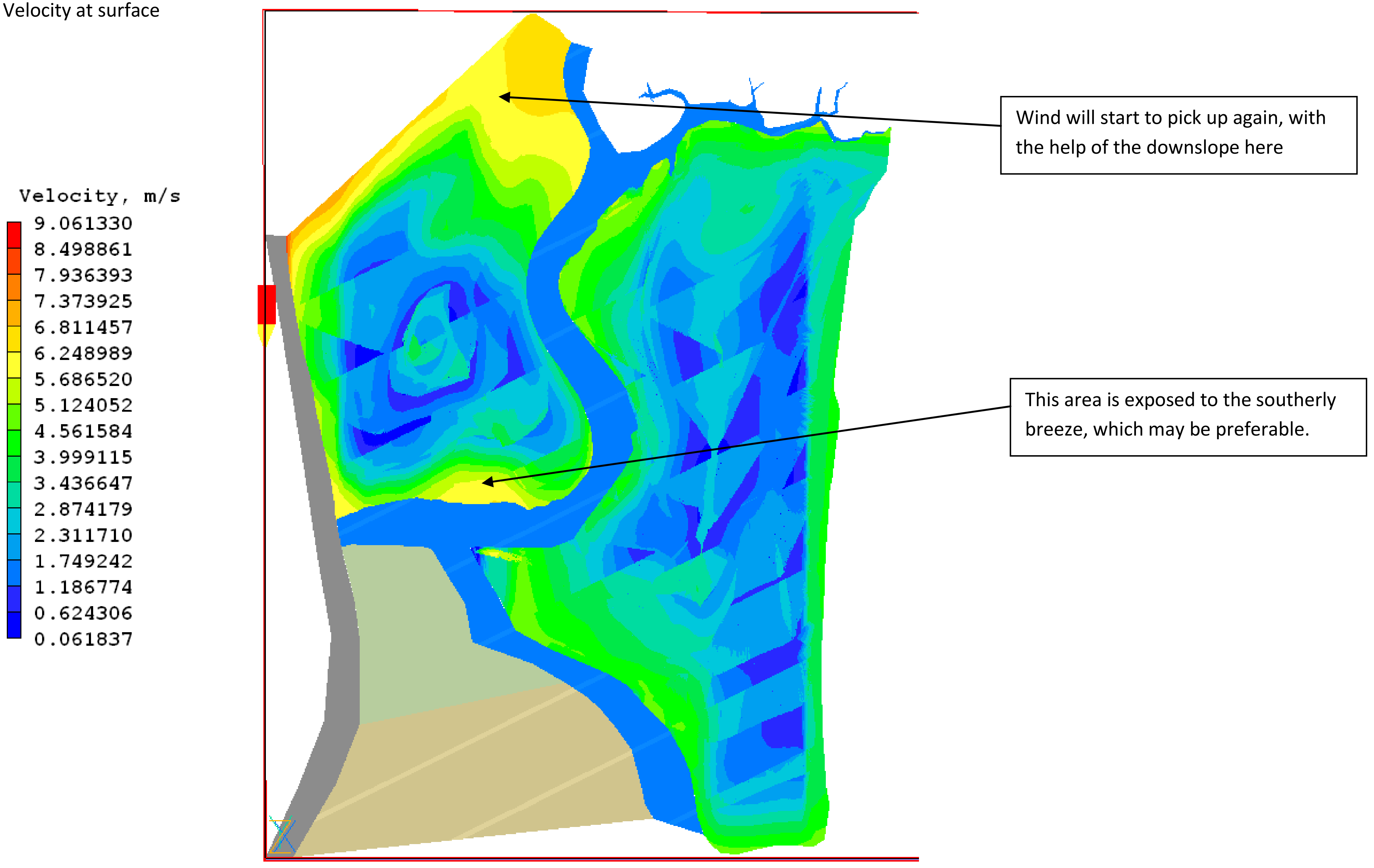
Wind Velocity and Direction. Grid plane section at 20m above ground level





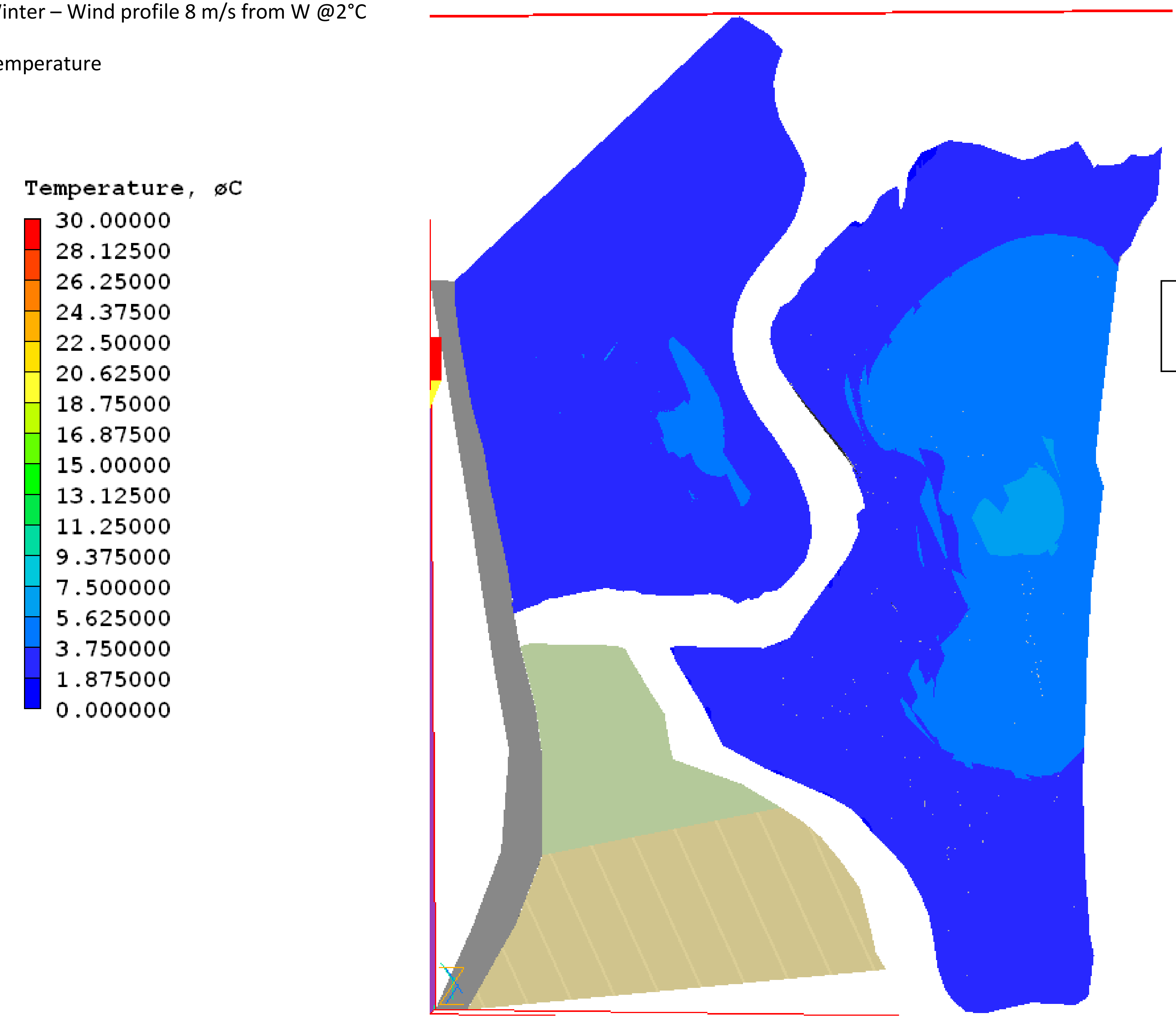
Summer - Wind profile 5 m/s from S @25°C

Wind Velocity at surface



Winter – Wind profile 8 m/s from W @2°C

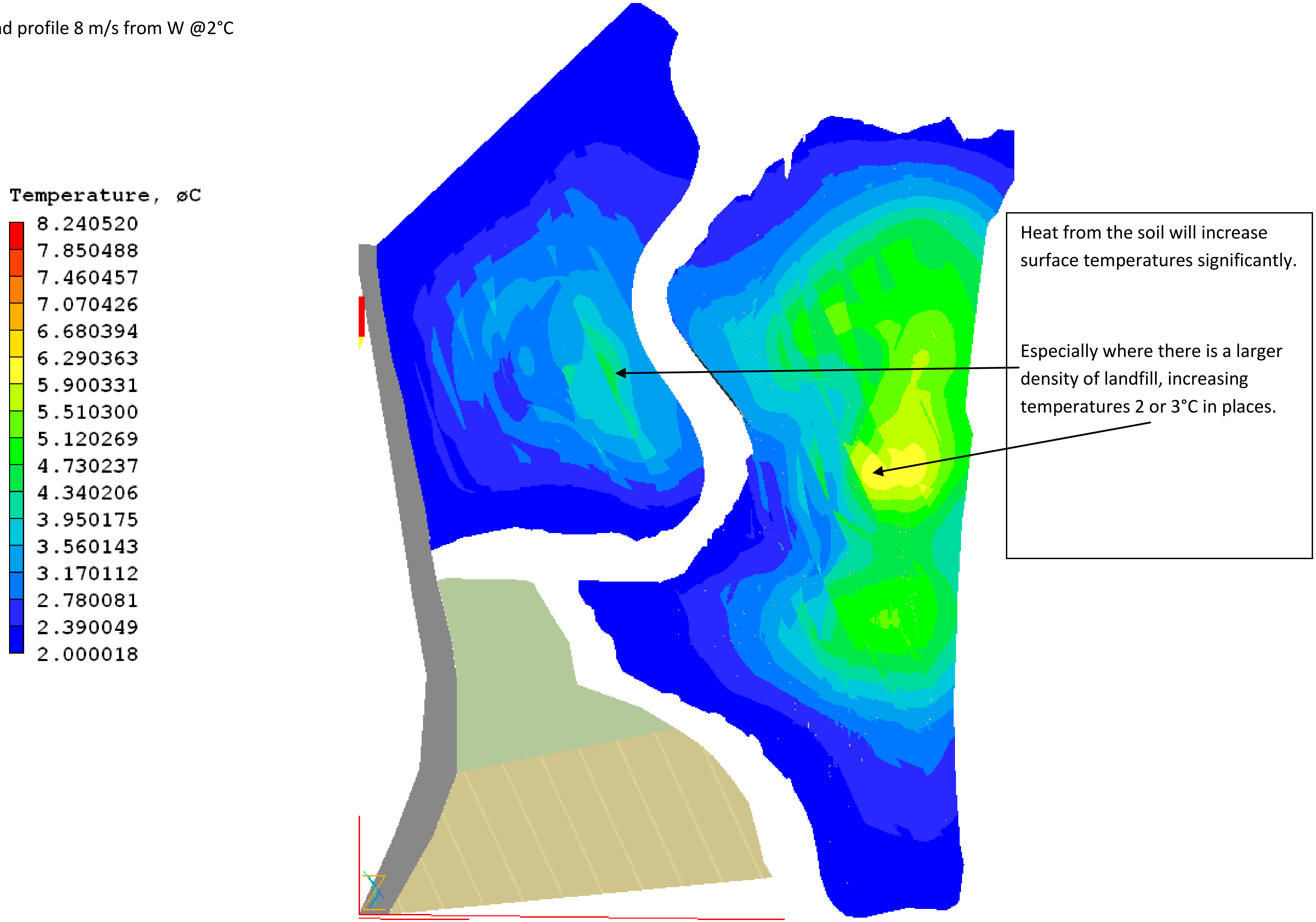
Temperature




Generally in winter, air temperatures are around 1 to 5°C

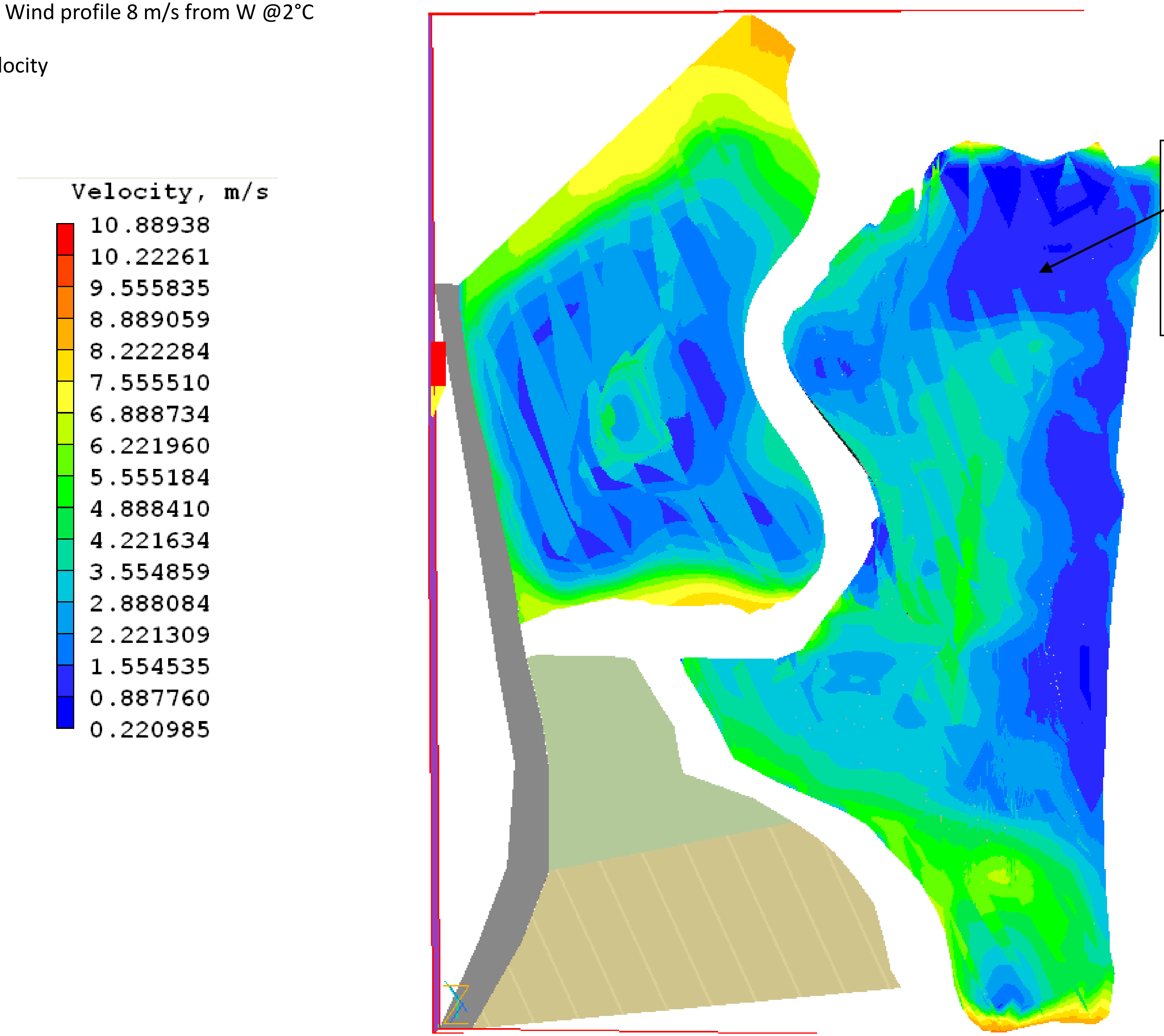
Winter – Wind profile 8 m/s from W @2°C

Temperature



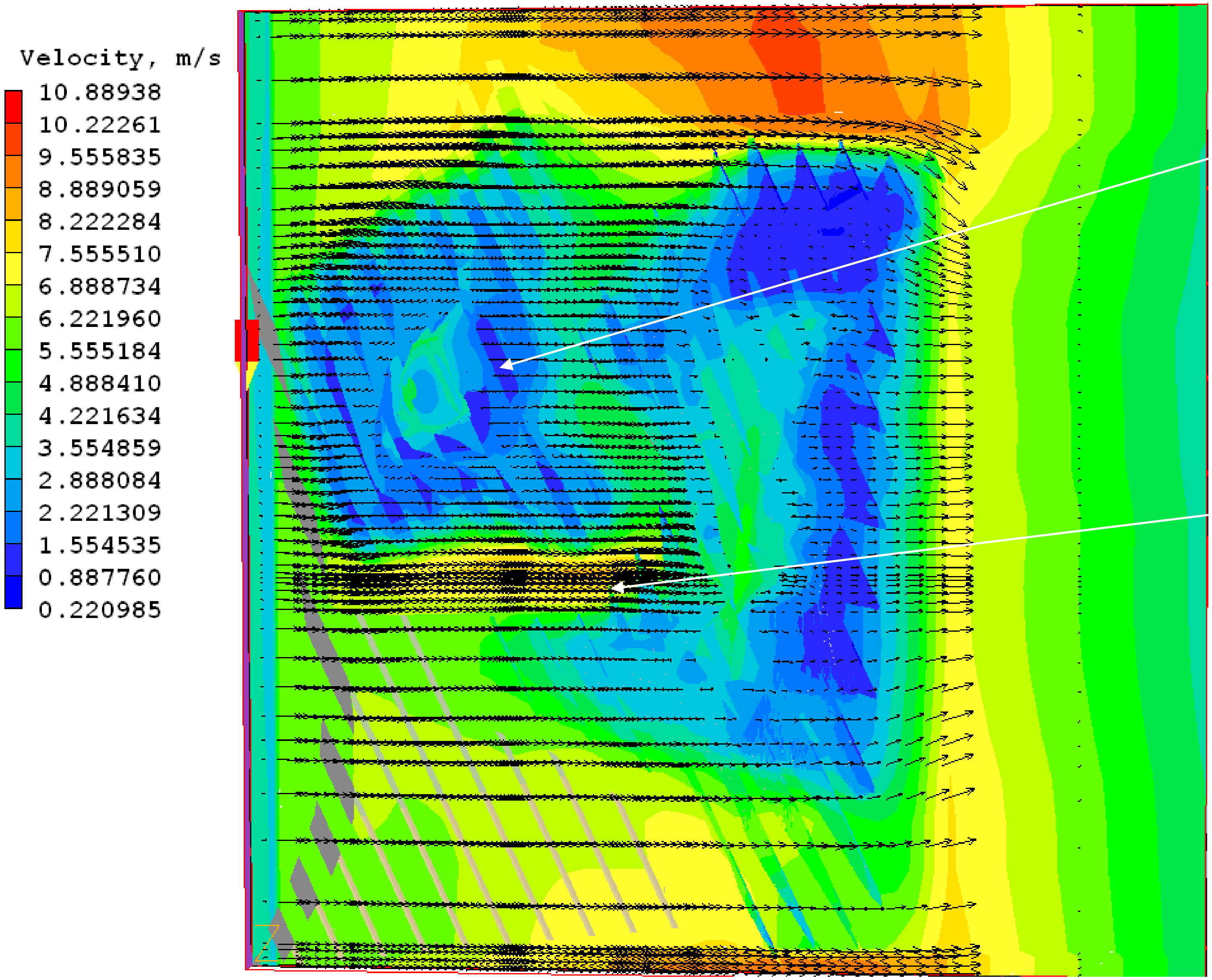
Winter – Wind profile 8 m/s from W @2°C

Wind Velocity




The forests still reduce wind velocity **significantly**, even though I slightly reduced the 'porosity' level, since it is likely in winter most of the trees will have less leaves etc.

Winter – Wind Velocity + Direction 8 m/s from W @2°C; Grid plane at 15m above ground level




The topography of the north park and trees shelter this area significantly

It seems that the river area/ channel between the two hills enables wind velocity to pick up here, and is forced against this side of the East Park.

| Microclimate Site | Season | Sun | Surface Type | T (°C) | Wind Velocity (m/s) | Turbulent kinetic energy (k) | Effective Gust (Veff) | q (kcal/m2/hr) | I | I (Direct) |
|---|---|---|---|---|---|---|---|---|---|---|
| A | Summer | Full Shade | Wood Decking | 24.54 | 2.98 | 0.10 | 5.81 | 243.26 | 616.47 | 0.00 |
| A | Winter | Sun | Wood Decking | 4.08 | 2.98 | 0.15 | 6.44 | 849.86 | 400.69 | 340.59 |
| B | Autumn | Sun | Concrete | 12.86 | 1.76 | 0.15 | 3.81 | 526.81 | 451.71 | 383.95 |
| B | Winter | Sun | Concrete | 3.47 | 3.10 | 0.10 | 6.04 | 855.80 | 400.69 | 340.59 |
| C | Summer | Full Shade | Forest Canopy | 23.06 | 2.48 | 0.10 | 4.84 | 274.45 | 616.47 | 0.00 |
| D | Summer | Sun | Water | 24.17 | 3.94 | 0.10 | 7.68 | 269.24 | 616.47 | 524.00 |
| E | Summer | Sun | Water | 20.91 | 1.18 | 0.10 | 2.29 | 281.70 | 616.47 | 524.00 |
| E | Winter | Sun | Water | 3.40 | 6.60 | 0.15 | 14.26 | 1005.05 | 400.69 | 340.59 |
| F | Summer | Sun | Water | 20.96 | 1.38 | 0.10 | 2.69 | 291.00 | 616.47 | 524.00 |
| F | Winter | Sun | Water | 2.81 | 4.51 | 0.15 | 9.75 | 963.75 | 400.69 | 340.59 |
| G | summer | Sun | Grass | 19.32 | 0.90 | 0.10 | 1.76 | 300.21 | 616.47 | 524.00 |
| H | Winter | Full Shade | Grass | 3.69 | 3.99 | 0.15 | 8.63 | 914.50 | 400.69 | 0.00 |

**Average Seasonal Irradiance**

| Spring | Summer | Autumn | Winter |
|---|---|---|---|
| 607.87 | 616.47 | 451.71 | 400.69 |

Pheonics Coordinates

| | x | y | z |
|---|---|---|---|
| A | 892.849731 | 1463.146973 | 15.840799 |
| B | 867.220337 | 1764.569946 | 17.434561 |
| C | 364.603943 | 2128.715332 | 14.0208 |
| D | 1159.793579 | 1424.392944 | 0.7448 |
| E | 1558.230469 | 1243.921021 | 36.577194 |
| F | 1403.070068 | 1576.390015 | 20.374561 |
| G | 1515.667969 | 1463.146973 | 31.66666 |
| H | 1600.793457 | 1576.390015 | 35.283989 |

########

| Di (Diffuse) | Temperature (Kelvin) | ε | Ei (Ground radiation) | Fi | Ei * Fi | αk | εp | αk/εp | Di * Fi | (αk/εp)*( Di * Fi) | fp * I * αk/εp | (Ei * Fi) +( (αk/εp)*( Di * Fi))+( fp * I * αk/εp) | Mean Radiant Temperature (without ^0.25!) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 616.47 | 78.371141 | 0.9 | 4.00E+10 | 0.5 | 2E+10 | 0.7 | 0.97 | 0.7216495 | 308.23572 | 222.43815 | 0 | 2E+10 | **35.27** |
| 60.10 | 58.945226 | 0.9 | 3.01E+10 | 0.5 | 1.504E+10 | 0.7 | 0.97 | 0.7216495 | 30.05212 | 21.687097 | 122.89355 | 1.504E+10 | **26.53** |
| 67.76 | 66.770774 | 0.94 | 3.56E+10 | 0.5 | 1.779E+10 | 0.7 | 0.97 | 0.7216495 | 33.877997 | 24.448039 | 138.53889 | 1.779E+10 | **31.38** |
| 60.10 | 58.42591 | 0.94 | 3.11E+10 | 0.5 | 1.557E+10 | 0.7 | 0.97 | 0.7216495 | 30.05212 | 21.687097 | 122.89355 | 1.557E+10 | **27.46** |
| 616.47 | 76.828086 | 0.38 | 1.66E+10 | 0.5 | 8.277E+09 | 0.7 | 0.97 | 0.7216495 | 308.23572 | 222.43815 | 0 | 8.277E+09 | **14.60** |
| 92.47 | 77.984919 | 0.67 | 2.96E+10 | 0.5 | 1.481E+10 | 0.7 | 0.97 | 0.7216495 | 46.235358 | 33.365722 | 189.07243 | 1.481E+10 | **26.12** |
| 92.47 | 74.62103 | 0.67 | 2.83E+10 | 0.5 | 1.417E+10 | 0.7 | 0.97 | 0.7216495 | 46.235358 | 33.365722 | 189.07243 | 1.417E+10 | **25.00** |
| 60.10 | 58.364526 | 0.67 | 2.22E+10 | 0.5 | 1.109E+10 | 0.7 | 0.97 | 0.7216495 | 30.05212 | 21.687097 | 122.89355 | 1.109E+10 | **19.55** |
| 92.47 | 74.667516 | 0.67 | 2.84E+10 | 0.5 | 1.418E+10 | 0.7 | 0.97 | 0.7216495 | 46.235358 | 33.365722 | 189.07243 | 1.418E+10 | **25.01** |
| 60.10 | 57.869724 | 0.67 | 2.20E+10 | 0.5 | 1.099E+10 | 0.7 | 0.97 | 0.7216495 | 30.05212 | 21.687097 | 122.89355 | 1.099E+10 | **19.39** |
| 92.47 | 73.018357 | 0.38 | 1.57E+10 | 0.5 | 7.867E+09 | 0.7 | 0.97 | 0.7216495 | 46.235358 | 33.365722 | 189.07243 | 7.867E+09 | **13.87** |
| 400.69 | 58.606755 | 0.38 | 1.26E+10 | 0.5 | 6.314E+09 | 0.7 | 0.97 | 0.7216495 | 200.34747 | 144.58065 | 0 | 6.314E+09 | **11.14** |